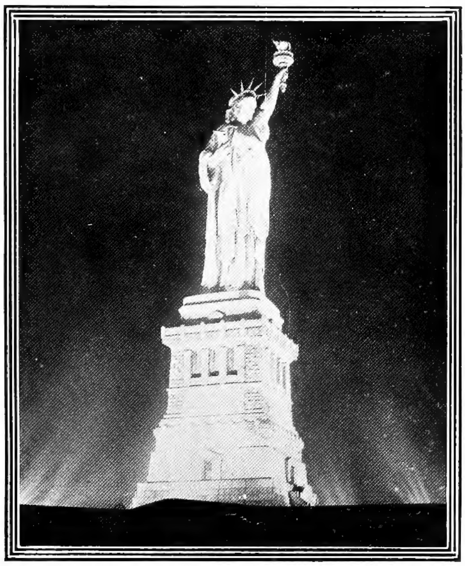
THE STORY OF ELECTRICITY

The Story of Electricity

VOLUME ONE

A POPULAR AND PRACTICAL HISTORICAL ACCOUNT OF THE ESTABLISHMENT AND WONDERFUL DEVELOPMENT OF THE ELECTRICAL INDUSTRY

With engravings and sketches of the pioneers and prominent men, past and present



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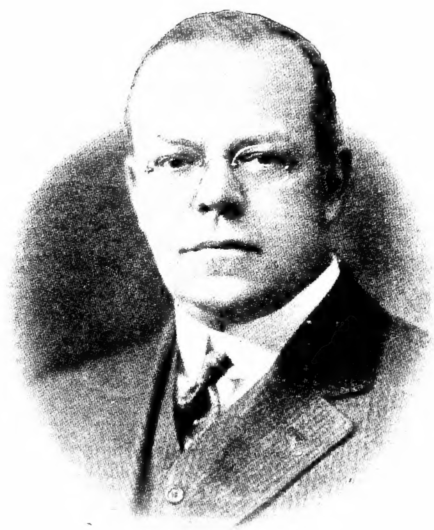

STEPHEN LEIDY COLES

THE STORY OF ELECTRICITY

PREFACE

THE intent of this book is to tell a plain story of the development of electricity. Considering the supreme importance of the electrical industry, affecting as it does to-day the home and business life of practically every citizen of this country, it is a remarkable fact that no history of its rapid and marvelous development has been produced—a development due to the initiative of progressive and far-seeing men and the employment of courageous private capital. This lack of adequate historical recognition is all the more surprising when it is understood that at the present time more than twelve billion dollars are invested in the electrical industry; that the people paid out last year over $3,500,000,000 for electrical service; that during the same period the public bought and used $750,000,000 worth of electrical devices, apparatus and supplies, and that conservative and authoritative estimates place the number of American people dependent upon the electrical industry for a living or support at 5,000,000, or one in every twenty of the country's population.

Hence the Editors of THE STORY OF ELECTRICITY take especial pleasure, pride and satisfaction in recording and arranging in an historical review the salient facts regarding an industry with which they have been actively connected since youth.

The Editors were both, for many years, electrical journalists whose daily work brought them into close contact with all but the very earliest pioneers in the telegraphic art. Acquaintance and friendship with the leading men of the industry during the past thirty-five years have enabled them, in the majority of instances, to secure accurate data regarding important events from the actual creators of the art or participants in those events. Suggestions that such a work should be prepared have been repeatedly made, and they feel that they are meeting a long recognized necessity for such an addition to the permanent literature of invention and industry. This history is written in the language of the layman, while at the same time its technical truth will satisfy the scientist.

It is thus possible to present an historical narrative at once accurate and authoritative, as well as one thoroughly permeated with that most desirable quality, "human interest." The personal sketches have been prepared with the utmost care, and no efforts have been spared to secure authentic portraits of the prominent members of this

great industry, both of the past and the present day. Contained within the covers of this volume, the casual reader or the student in search of information will find not only the facts he is seeking, but at the same time he may, by consulting the index, turn to portraits and reliable biographies of the men concerned in the events described.

Although this volume is primarily a history, the general reader will find the narrative pleasantly punctuated with descriptions of absorbingly interesting events such as the romance of the telephone, from the stringing of the first experimental line between Cambridge and Boston to the modern "coil-loaded" and "phantom" circuits which makes possible the transmission of speech between New York and San Francisco; the hazardous exploits performed by adventurous pioneer inventors in the electric railway field—such as riding on the truck of a street car and holding in place the electric motor which had jarred loose from its fastenings; the thrilling and dangerous expeditions into the jungles of the Far East in search of the exact species of bamboo required for incandescent lamp filaments; the steady, grinding, stubborn hours of ceaseless experiment which finally resulted in apparatus that renders possible the moving picture of today; the stirring account of the epoch-making discovery of a way to subdivide the electric current by which house-lighting by electricity became possible; the narrative of the important commercial inroductions of the alternating current which enables electrical energy to be delivered for useful work at points far distant from its source of generation; the account of the patent litigation, acrimonious legal strife and bitter business battles waged by the partisans of "direct" and "alternating" current systems; the mysterious and wonderful electro-chemical reactions that take place in the operation of a storage battery; and over all, partly to be read beween the lines and partly emblazoned as high lights of industrial progress and human achievement, spreads the glamour of pioneer hardships and business chances undertaken and endured by adventurous men of faith and vision and commercial sagacity, many of whom have after all realized but a small if any part of their just reward. For the majority of them the consciousness of having rendered conspicuous public service must forever suffice.

The subject is a wonderful one. The Editors have endeavored to treat it so as to preserve as much as possible of that atmosphere or sentiment of co-operative effort which binds electrical men into the fraternity that has enabled them to give more of comfort and service to humanity than any other group of professional workers the world has ever known.

T. COMMERFORD MARTIN
STEPHEN LEIDY COLES

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SUMMARY OF CHAPTERS

THE STORY OF ELECTRICITY

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CHAPTER I

ORIGIN OF ELECTRICAL SCIENCE

Historical Sketch of the Discovery and Development of Electrical Phenomena

As this book probably will fall into the hands of many readers who have no knowledge of electricity whatever, it has been suggested to the authors that a preliminary historical sketch of the growth of electrical discovery and experimentation from the earliest times would be helpful to a clearer understanding of what has been accomplished in the United States in the past half century in this remarkable field of development.

The account which follows, while covering the subject in the briefest possible manner, has been written to meet this suggestion and with the hope that the layman may glean from it enough to make plainer and more interesting to him the other chapters of the book.

The period of Thales, a Greek philosopher, about 600 B. C., is generally taken by historians as the genesis of electrical discovery. Thales was a mathematician, an astronomer and an all around wise man of his day. Having these qualifications, which are historically well authenticated, it is logical to assume that his faculty of observation was well developed. Therefore, when he is credited with the observation that if a piece of amber is rubbed against the clothing it will first attract and then repel light objects brought near it, it seems safe to assume that even if he was not the original discoverer he, at least, was the first to record the phenomenon upon which so much later knowledge has been founded.

That Thales was not lacking in the attributes of the modern business man is shown in an anecdote related of him by Benj. Martin in his "Biographia Philosophica," London, 1764, as follows:

"Thales being upbraided for his Poverty, resulting from the Study of Science, and foreseeing by his Skill in Astrology there would be plenty of Olives that year, purchased all the gardens about Miletus and Chios, and thus having acquired a Monopoly, disposed of them again at High Prices, and then told his Neighbors that it was very easy for Men of Learning to be rich if they chose it, but that Wealth was not their Aim."

Because of its suggestion of sunlight, the Greeks named their beautiful, golden amber "elektron," from which our "electricity" readily descends. Here, then, we have the beginning of things electrical—the original and first experiment made and recorded and the derivation of the name for the specific form of energy on which all our latest developments depend.

About the time of Thales, Aristotle is reported to have said: "The stone has a soul since it moves iron." It is supposed that he referred to the lodestone, or particular variety of iron ore called "magnetite," which possessed the power of attracting similar pieces or small particles of iron. The city of Magnesia produced the best specimens of these stones. Thus we have a source for our terms "magnetism" and, later, "magnet."

Some 300 years after Thales, Theophrastus the Greek showed that certain species of tourmaline when rubbed acquired similar properties to amber. In his

work on precious stones he states that "amber is a stone. It is dug out of the earth in Liguria and has a power of attraction. It is said to attract not only straws and small pieces of sticks, but even copper and iron, if they are beaten into thin pieces."

At an indefinite date, probably some time before 100 A. D., Plutarch records the fact that it had been observed that "iron drawn by stone often follows it, but often also is turned and driven away in the opposite direction."

This, then, is the sum of our knowledge of electrical phenomena at the beginning of the Christian era. For 2,000 years Thales' original experiment lay dormant and was productive of nothing. From our modern standpoint it seems most remarkable that the existence of electrical energy should have remained so long unrecognized. The world was not lacking in brilliant minds, for the Egyptians, the Greeks and the Romans possessed a high order of culture and intellectual development. In the words of Dr. Edwin J. Houston, "the road leading into the unknown domain of electric science was pointed out to them, but this road was neglected and soon forgotten, and, only during the past one hundred years or so, became the great thoroughfare of scientific progress."

The centuries are barren of electrical advance until Dr. William Gilbert, physician to Queen Elizabeth, of England, showed that many bodies besides amber and tourmaline, when rubbed, attracted and then repelled light particles brought near them.

Gilbert, who was born in 1540, published his observations in 1600 in a book entitled "De Magnete," which is among the very earliest printed records relating in any way to electricity. He described a large number of experiments. His mental development, which was beyond the average, gave him the enduring distinction of being the first man after a lapse of 2,000 years to extend the original observation of Thales. Gilbert was a contemporary of Bacon, who taught a system of inductive philosophy under which the causes of phenomena are determined by careful experimentation and the facts obtained from one series of experiments are used as the basis for further experiments. Gilbert's work, although leading him to erroneous conclusions in a number of instances, bears evidence of having been carried on according to Bacon's methods of philosophy. Gilbert's researches and the important fact that he recorded them in a printed book have resulted in the bestowal upon him of the title "Father of

DR. WILLIAM GILBERT
First Systematic Investigator of Whom there is any Record

Electricity." He also is credited with having invented the name "electrica,"or "electrics," to describe those bodies which possess the amber attraction. Thus he provided a root for our word "electricity."

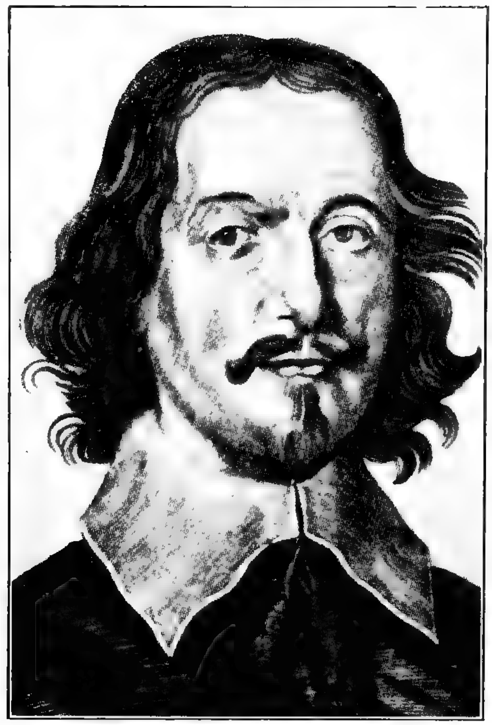
The adaptation of a piece of magnetized iron for use as a mariner's compass has been credited to the Chinese and also to seafaring men of the Northern European countries. The first description of the device, however, was made by Alexander Neckham, an English monk, in 1180. He assumed a knowledge of the facts that if a natural magnet, or lodestone, is suspended and free to turn about a vertical axis the same portion of the magnet will always point to the north; and that if a piece of iron is rubbed with a lodestone it will acquire temporarily the properties of the lodestone.

Gilbert made and described many experiments with the compass. He amplified Robert Norman's assumption that the magnet is surrounded by an "orb of virtue" by imagining that his sphere of influence extended to infinity and called "rays of magnetic force" the lines along which the magnetic force was exercised. In consonance with Gilbert's theories we speak today of the "field of force" surrounding a magnetic pole and refer to his rays as "lines of force." Gilbert also found that, while magnetic action is strongest at the poles of a lodestone magnet, the force permeates the whole mass and that if it be broken up each part becomes a magnet with its own north and south poles. Another of his discoveries was that the magnetic attraction of a lodestone for iron particles can be cut off by the interposition of any substance except iron and also that the iron particle is magnetized before it touches the magnet, having a polarity opposite to that of the magnet. Therefore the north pole of a magnet induces in the approaching iron particle a south pole and these two unlike poles attract each other. Thus the important principle of magnetization by induction is established.

The flow of electric current through a conductor was demonstrated by Gilbert's experiment that the magnetic force moves from one end of an iron rod to the other when one end is in contact with a magnet.

Otto von Guericke, burgomaster of Magdeburg, about this period had been making experiments with the amber attraction. In order to save time and labor in rubbing the amber by hand he made, in 1650, a machine consisting of a large ball of sulphur mounted on a shaft which could be revolved. His hand laid on the surface of the ball acted as the rubber. Placing a linen thread in contact with the globe and revolving his machine, he made the important discovery that, just as Gilbert found that magnetism passes from one end of an iron rod to the other, the electric attraction appeared at the distant end of the thread. Thus was established the principle that electric attraction could be "conducted" and made evident at a point distant from its source. In this primitive laboratory in Magdeburg, therefore, was born the "electrical transmission of energy."

About 1700 Francis Hawksbee, an Englishman, built a similar machine with a glass globe in place of the ball of sulphur. By means of a belt and crank shaft the globe could be revolved at high speeds. Exhausting the air from the globe and rubbing it while it revolved produced a glowing light in the sphere. When this experiment was performed before the Royal Society great excitement was created by the "electric light."



OTTO VON GUERICKE
First to Conduct Experiments with a Special Machine

Stephen Grey, an Englishman, in 1729, first called attention to the difference between conductors and non-conductors of electricity. Using threads of hemp supported by silk threads he transmitted the electric attraction a distance of 1,000 feet. His further experiments demonstrated that while linen, hemp or metal would conduct electricity, silk was a non-conductor. A Frenchman, Charles du Fay, repeated these experiments and records, in 1733, that the hempen thread, when supported by silk threads, is "insulated." An "insulator," therefore, is a substance which conducts electricity so poorly that the amount passing through it is negligible.

As the amount of electricity produced by the various frictional machines of these pioneer experimenters was very small, a demand grew up for a device that would either store these small quantities until a large total had accumulated or a machine that would itself generate large quantities of the electric fluid. Hence it happens that 1745 proved to be a memorable year in the advancement of electrical experimentation, for at this date Bishop Von Kleist, dean of the cathedral of Comin, Pomerania, discovered the Leyden jar. While this discovery has been credited to others, Dr. Joseph Priestley, in his "History and Present State of Electricity, with Original Experiments," London, 1775, attributes the discovery to Von Kleist.

The Leyden jar, or phial, gets its name from the fact that Cunaeus, of Leyden, while repeating some experiments with Professors Muschenbroeck and Allamand, of the University of Leyden, independently made the same discovery as Von Kleist. In a letter from Von Kleist, dated November 4, 1745, read before the Academy of Science at Berlin, he describes his discovery as follows:

"When a nail, or a piece of thick brass wire, &c., is put into a small apothecary's phial and electrified, remarkable effects follow; the phial must be very dry or warm. I commonly rub it over beforehand with a finger, on which I have put some pounded chalk. If a little mercury, or a few drops of spirit of wine, be put into it, the experiment succeeds the better. As soon as this phial and nail are removed from the electrifying glass, or the prime conductor, to which it hath been exposed, is taken away, it throws out a pencil of flame so long, that, with this burning machine in my hand, I have taken above sixty steps, in walking about my room. When it is electrified strongly, I can take it into another room, and there fire spirits of wine with it. If while it is electrifying, I put my finger, or a piece of gold, which I hold in my hand, to the nail, I receive a shock which stuns my arm and shoulders."

About this time a number of experimenters investigated the Leyden jar effects and most of them describe extravagantly the sensations produced on themselves by the electric discharge. It is altogether probable, from what is now known of the character of the jars then constructed, that the shocks obtained must have been trivial. Professor Allamand reports that Bohemian glass was the best kind to use and further remarks: "That with which it (the experiment) best succeeded was a beer glass."

The discovery of the Leyden jar and its independent study by a number of experimenters undoubtedly marks a most important milestone in electrical progress. It is a fact that some of the most interesting advances in electrical science in modern times have been founded on the basic principles of the Leyden jar. The researches of Dr. Elihu Thomson and Nikola Tesla on the effects produced by alternating currents of high frequency are notable examples of this.

Recalling the occasions without number when the wiseacre layman has feelingly remarked that "electricity is only in its infancy," it is interesting to note the observations of one Tiberius Cavallo, who published a treatise in three volumes on electricity in 1795. Referring to the Leyden jar, he says:

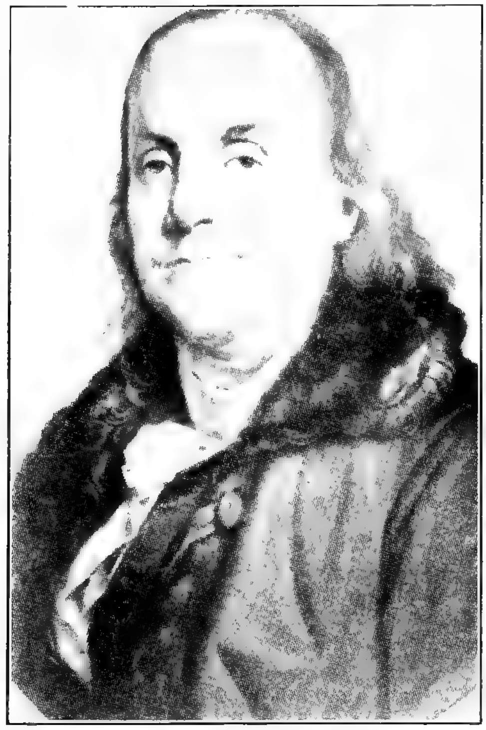
"Since the time of this discovery, the prodigious number of electricians, experiments and new facts that have been daily produced, from every corner of Europe, and other parts of the world, is almost incredible. Discoveries crowded upon discoveries; improvements upon improvements; and the science ever since that time went on with so rapid a course, and is now spreading so amazingly fast, that it seems as if the subject would soon be exhausted, and electricians arrive at an end of their researches; but, however, the *ne plus ultra* is, in all probability, as yet at a great distance, and the young electrician has a vast field before him, highly deserving his attention, and promising further discoveries, perhaps, equally, or more important than those already made."

The ubiquity and fascination of electrical experimentation had their start about this time, when news of the discoveries in Europe reached the colonists in America. Benjamin Franklin, a Philadelphia printer, in 1746, repeated the Leyden jar experiments for his own amusement. He had already, in 1742, made the immortal discovery with his silken kite that lightning and the artificial discharge from the Ley-

den jar are identical. The practical application he made as the result was the invention of the lightning rod. Franklin's own description of his kite experiment is given in one of his letters which, later, was published in his book, "Experiments and Observations on Electricity, made at Philadelphia, in America." The letter is as follows:

"As frequent mention is made in public papers from Europe of the success of the Philadelphia experiment for drawing the electric fire from clouds by means of pointed rods of iron erected on high buildings, &c., it may be agreeable to the curious to be informed that the same experiment has succeeded in Philadelphia, though made in a different and more easy manner, which is as follows:

"Make a small cross of two light strips of cedar, the arms so long as to reach to four corners of a large, thin, silk handkerchief when extended; tie the corners of the handkerchief to extremities of the cross, so you have the body of a kite; which being properly accommodated with a tail, loop, and string, will rise in the air, like those made of paper; but this being of silk, is fitter to bear the wet and wind of a thunder-gust without tearing. To the top of the upright stick of the cross is to be fixed a very sharp pointed wire, rising a foot or more above the wood. To the end of the twine, next the hand, is to be tied a silk ribbon, and where the silk and twine join, a key may be fastened. This kite is to be raised when a thunder-gust appears to be coming on, and the person who holds the string must stand within a door or window or under some cover, so that the silk ribbon may not be wet; and care must be taken that the twine does not touch the frame of the door or window. As soon as any of the thunder clouds come over the kite, the pointed wire will draw the electric fire from them, and the kite, with all the twine, will be electrified, and the loose filaments of the twine will stand out in every way, and be attracted by an approaching finger. And when the rain has wet the kite and twine, so that it can conduct the electric fire freely, you will find it stream out plentifully from the key on the approach of your knuckle. At this key the phial may be charged; and from electric fire thus obtained, spirits may be kindled, and all the other electric experiments be performed, which are usually done by the help of a rubbed glass globe or tube, and thereby the sameness of the electric matter with that of lightning completely demonstrated."



BENJAMIN FRANKLIN

Discoverer of the Positive and Negative characteristics of Electricity, and Inventor of the Lightning Rod

Franklin's further observations on the Leyden jar brought him the knowledge that when it was charged from the frictional electric machine the inner coating of the Leyden jar connected to the machine was positive and the outer coating negative. Having established this fact to his satisfaction, he made a Leyden jar which easily could be taken apart and began a series of experiments to discover where the electricity was stored. By using a sheet of glass with thin lead on each side he found that the electricity did not rest in the lead coatings but was on the surfaces of the glass, and was held there by the attraction of opposite electrifications until a path was provided by which the positive and negative charges could join each other.

Until now European observers had believed that the electricity was held in the iron filings, or the lead plates, or the water used to fill the Leyden jar. Franklin's theory, however, in the course of time prevailed and displaced all others.

As a natural sequence of this theory, it followed that if the surface of the glass was where the electricity was stored, all that had to be done to secure an increased charge was to enlarge the glass surface; that is, two jars properly connected would contain twice the charge of one jar or have twice the "capacity." Franklin, therefore, increased his battery of jars to six or more and succeeded in securing a discharge sufficient to kill a ten pound turkey. When Franklin had his battery of jars arranged so that all the inner coatings were connected together and all the outer coatings connected with each other, making, in effect, a single large jar, he said the jars were "connected in parallel." When the outer coating of the first jar was connected to the inner coating of the second, and so on, he called the connection "cascade." While we still use Franklin's term "parallel" connection, we now call his "cascade" connection "series."

Franklin continued his electrical investigations along with his other activities, but the proof of the identity of the electric spark and the flash of lighting and the invention of the lightning rod gave to the world the first practical results of electrical experimentation. It had now been about 150 years since Gilbert's classic discoveries in magnetism. The sum of practical electrical knowledge at this time was, therefore, contained in the work of these two men.

Luigi Galvani, professor of anatomy in the University of Bologna, made a memorable discovery in 1786. While carrying on some experiments in the effects of atmospheric electricity on animal organisms he accidentally found that the dismembered leg of a frog was violently convulsed when charged with electricity. As he had been searching for the vital fluid which could be credited with being the cause of vitality, he supposed he had found it, and his published accounts of this experiment make such a claim, which we now know to be erroneous. The excitement produced by Galvani's announcement was widespread and his experiments were repeated by many observers in the scientific world.

Among these was Alexander Volta, professor of physics in the University of Pavia, who, while at first accepting his conclusions, afterwards decided that Galvani had really discovered a new method

ALEXANDER VOLTA
Discoverer of the Voltaic Pile. The Most Important Advance up to that Time

of producing electricity instead of the vital force of life, as he had announced. As a result of his experiments Volta announced in 1796 the voltaic pile, one of the most important inventions ever made in the electrical arts. It is interesting to note that Volta was so far in advance of his time with this invention that he stirred up no rival claimants, a really unique distinction. The voltaic pile, which was the first generator of a continuous electric current, was referred to by Arago as "the most wonderful apparatus that has ever come from the hand of man, not excluding even the telescope or the steam engine."

Volta's pile, first exhibited in 1800, consisted of a series of disks of silver, zinc and cloth wet with salt water. The disks were about an inch in diameter and were

assembled in a column in regular order—silver, zinc, cloth, repeated until the desired number was reached. In the inventor's own words, this procedure resulted in "the construction of an apparatus which resembles, so far as its effects are concerned — that is, by the commotion it is capable of making one feel in the arms, etc.—the Leyden batteries, and still more the fully charged electric batteries. It acts, however, without ceasing, and its charge re-establishes itself after each explosion. It operates, in a word, by an indestructible charge, by a perpetual action or impulse on the electric fluid." The capacity of the pile, moreover, was in exact proportion to the number of metallic plates used. One hundred pairs produced a distinct shock and 500 pairs a very painful one. As compared with a Leyden jar, the greatest improvement in the voltaic pile was its continuity of electric discharge. This was true as long as the disks of cloth remained moist. When they became dry the action of the pile ceased entirely. Volta overcame this defect by devising his "crown of cups," the cloth disks being replaced by glass vessels filled with salt water and strips of silver and zinc taking the place of the metal disks. In this apparatus the silver in one glass cup was connected to the zinc in the next cup, the silver in this to the zinc in the next, and so on; a "series connection" like the Leyden jar battery.

Experiments with the new voltaic pile soon demonstrated that more vigorous action could be obtained by replacing the salt water in the cups with a weak solution of sulphuric acid. Then it was found that the acid rapidly dissolved the zinc even when the pile was not discharging current and that hydrogen gas was given off at the zinc. To save this waste of metal the strips were attached to a frame which could be raised out of the acid solution when the apparatus was not in use. Thus came about the invention of the "plunge battery." It also was found that the waste of metal could be stopped, even if it were left in the acid bath, if the zinc strips previous to use were rubbed with mercury, or "amalgamated." Now, while no gas was generated while the cells were at rest, a copious discharge took place as soon as the complete circuit was established between the end plates and the zinc was consumed in direct proportion to the electric discharge drawn from the cell. New theories for the action of the cell were now advanced. It was recognized that somewhere in the apparatus a force was evolved which had the ability to move electricity through a closed path. The cells

SIR HUMPHRY DAVY
First to Exhibit a Practical Electric Light

themselves had been referred to as "electro-motors" or electricity movers. This force, then, was called "electro-motive force," a term still important in our electrical vocabulary.

A great number of valuable discoveries and inventions followed, now that Volta had placed at the disposal of investigators a simple and easy means of producing electricity. One of these discoveries was that of Nicholson and Carlisle, made in 1800, which proved that an electric current passed through a compound liquid decomposes the liquid. Their voltaic pile consisted of thirty-six English half-crowns, alternating with the same number of zinc disks, the two metals separated by disks of pasteboard soaked in salt water. With this apparatus, Nicholson and Carlisle showed that when current was passed

through salt water the water was decomposed and oxygen and hydrogen were liberated.

Sir Humphry Davy, by using this method on October 6, 1807, made the important discovery of the compound nature of potassa, a substance which theretofore had been regarded as elementary. He demonstrated that postassa was composed of the hitherto undiscovered metallic element potassium combined with oxygen. Later he demonstrated that the earth's crust is almost entirely formed of metallic elementary substances combined with oxygen or other substances.

Although it was discovered very shortly after the invention of the voltaic pile that a bright light is produced at a break in the circuit of a sufficiently powerful pile, it was Sir Humphry Davy who, in 1809, showed at the Royal Institution in London for the first time on an extended scale the brilliant light of the voltaic arc which he established, with a pile formed of 2,000 couples, between two sticks of carbon. Strictly speaking, this was not the first arc light, yet it was undoubtedly the first time it was publicly shown in such a way as to demonstrate its possibilities as an artificial illuminant. While many futile attempts were made from this time on to produce a commerciallly practical arc light, it was not until nearly seventy years later that the problem was solved.

Gilbert had shown the many points of difference between electrical and magnetic phenomena and had proved fallacious the belief of the early philosophers that electric and magnetic attractions were identical, yet the opinion prevailed among many experimenters that there was a definite relation between magnetism and electricity. Hans Christian Oersted, professor of physics in the University of Copenhagen, was a scientist who held such views. One day in 1819, while addressing his students, he happened to hold a highly charged wire over a large magnetic needle which had come to rest in its normal position on the lecture table. To the astonishment of the professor, the needle swung about and took up a position at right angles to the charged wire. Oersted promptly began a series of experiments to establish the relation he suspected between magnetic and electrical phenomena. He found that if he reversed the current the needle deflected in the opposite direction. If the current flow remained unchanged and the charged wire was moved from above the needle to below it, the direction of deflection also reversed. In July, 1820, Oersted published his book "Experiments on the Effect of the Electric Conflict on the Magnetic Needle," which recounted these and many similar facts he had carefully observed.

PROF. ANDRE MARIE AMPERE
First to Introduce the Magnet

After carefully repeating Oersted's experiments and making many of his own, Andre Marie Ampère, professor of mathematics in the Ecole Polytechnique of Paris, published his theory of these phenomena. His famous rule for the direction of movement of the needle in Oersted's original experiment was: "Imagine yourself swimming in the wire in the direction of the current and facing the needle, then the north pole will be deflected toward your left hand." Carrying his work further, Ampère made the important discovery that currents in opposite directions repel and currents in the same direction attract each other. From this he

developed the theory which resulted in his construction of a long spiral coil of wire called a "solenoid" which, when connected to a battery, showed all the characteristics of a magnet.

Sturgeon, in 1825, discovered that a round iron bar placed within the solenoid acquired a magnetic strength many hundred times that of the solenoid alone; and that when the current supply was cut off the magnetism of the bar disappeared. These cored solenoids were called "electro-magnets" by Sturgeon and are today important parts of nearly all electrical apparatus. In 1830 an electro-magnet was constructed of 700 feet of wire and weighing 60 pounds which could support a ton weight when charged with electric current from a few cells of battery.

Years before this, or as soon as it became known that electricity transmitted its effects through conductors practically instantaneously, experimenters had suggested that such a method be used for communication between distant points. Herein lies the germ of the modern telegraph. But there were two requisites necessary before a system of telegraphy could be made practical. One was the electro-magnet discovered by Sturgeon, as noted above. The other was a source of current which would give a constant supply. In 1836 Daniell invented a voltaic pile, or battery, which differed from others in that it was capable of yielding for long periods of time an approximately steady current. These two important inventions, therefore, made the later invention of the telegraph a possibility.

The year 1837 is an important date in the annals of telegraphy. A number of claimants to the honor of inventing the modern telegraph appear, among them being Samuel F. B. Morse in the United States, Steinheil in Munich, and Wheatstone and Cooke in England. Previous to this time, Morse had devoted much thought and attention to the elements of his final invention for the honor of which the scientific world at last awarded him credit. He has told how the germs of the invention took root in his consciousness on board the packet ship "Sully" while en route from Havre, France, to New York City. The "Sully" sailed from Havre October 1, 1832, and during the voyage Morse made many sketches of his telegraphic apparatus. He uses these words: "I also drew in my sketch-book modes of interring the conductors in tubes in the earth, and, soon after landing, planned and drew out the method upon posts." Here we have what is probably the first suggestion that electric conductors can be carried in tubes underground, although Morse did not use it in his pioneer telegraph work. Morse completed his first telegraph instrument in 1835, three years after the "Sully" arrived in New York. It was in 1837, however, that his instruments and system were exhibited to the public generally.

The Morse system of telegraphy consisted in using an electro-magnet to the armature of which was attached a stylus, or pen, that recorded on a ribbon of paper, drawn beneath it, a series of dots and dashes corresponding to the letters of the alphabet. Prof. J. D. Forbes, in the "Encyclopaedia Brittanica," commenting on the systems of telegraphy contemporary with Morse, refers to the latter's apparatus as being entirely original and continues: "The telegraphs of Morse have the inestimable advantage that they preserve a permanent record of the dispatch they convey."

Since 1837 we find an almost continuous record of progress in the development, refinement and expansion of capacity of the telegraph. Duplex telegraphy, by which two or more messages are sent simultaneously over the same wire; contraplex, or the sending simultaneously of two or more messages in opposite directions; Delaney's system, by which as many as 72 separate and distinct messages have been successfully transmitted over the same wire, either all in one direction or a number in one direction and the remainder in the opposite direction; the simultaneous sending over one wire of two or more telegraph messages which at the same time was transmitting two or more telephonic conversations—these are only a few of the wonders accomplished through Morse's invention.

The classic researches and investigations of Michael Faraday undoubtedly made available for the world that wonderful and remarkably efficient source of electrical energy, the dynamo. Passing over

the interesting labors of other experimenters, it is sufficient for our present purpose to state that the first electric dynamo was invented by Faraday and was described in a paper read before the Royal Society of Great Britain in 1831.

Faraday's epoch marking invention, which he modestly called "A New Electrical Machine," consisted of a copper disk about 12 inches in diameter, so mounted on an axis as to be capable of rotation between the opposite poles of a strong permanent magnet. Two collecting brushes, one resting on the axis and the other on the circumference of the wheel, were provided to collect and carry off the current generated by means of the potential difference produced as the rotating disk cut through the lines of magnetic force of the permanent magnet. This was the first time that electric current was produced from a permanent magnet.

MICHAEL FARADAY
Inventor of the First Electric Dynamo

Working along similar lines, numerous inventors made dynamos of larger size and more power. Among these may be mentioned Dal Negro, Pixii, Ritchie, Clarke, Saxton, Jacobi, Sturgeon, Wheatstone, Brett, Page, Holmes, Wilde and the inventors of our own times. Faraday's invention for transforming mechanical effort into electrical energy with marvelous efficiency was of far more importance than even he realized and constituted a step of progress of immeasurable benefit to the world.

Now that electricity could be produced reliably, cheaply and in quantity it was possible to commercialize many applications hitherto confined to mere laboratory experiments. The first of these was the use of electric light for artificial illumination on a commercial basis. The arc light was the earliest result of these conditions. Some years previously Staite, one of the ablest advocates of the commercial arc light, had invented several types of arc lamp; but his work at the time came to nothing because he was dependent for his current on the expensive voltaic batteries.

Bunsen, in 1840, devised a process of making carbon rods for use in arc lamps. He mixed with molasses ground carbon obtained from the retorts of illuminating gas plants, moulded the rods into shape and then subjected them to great heat. This identical process, with slight variations, is that used today in the manufacture of arc lamp carbons. Deleuil and Archerau, in 1844, made two arc lamps which were installed in Paris. But again the cost of current from batteries halted progress.

By 1866, however, a sufficiently powerful and efficient dynamo of the Faraday type was built to allow the installation of arc lights in a few lighthouses in France and England and even to light the yacht of Prince Napoleon. From now on, as the inherent problems of the arc lamp itself developed, they were met and successfully solved by inventors such as Hefner von Alteneck, Charles F. Brush, Elihu Thomson, Dr. Edwin J. Houston, Sigmund Bergmann and others.

While the arc light gradually grew into a commercial device, perfectly satisfactory for the illumination of streets, large open spaces and auditoriums, it was not suitable for lighting residences or other small, confined interiors.

The great problem now confronting the electrical inventors of the world was to produce something smaller, better and more efficient than the arc light which

could be used for interior illumination. The solution of this problem, through his wonderful invention of the modern incandescent lamp, by Thomas Alva Edison is considered by many scientists and others as the crowning achievement of his remarkable life work. The divisibility of the electric arc light was now an accomplished fact the effects of which on the world's progress and comfort were not even dreamed of at the time.

In his laboratory at Menlo Park, N. J., on October 21, 1879, after strenuous and nerve-racking days and months of intense application, Edison produced an incandescent lamp with a filament of carbonized cotton sewing thread sealed in a glass globe exhausted to a vacuum of one thirty-thousandth of an atmosphere, which burned for forty hours.

As early as 1820 De la Rue had produced an electric lamp composed of a coil of platinum enclosed in a glass tube from which the air could be exhausted. The coil glowed brightly for a very short time, then broke down and had to be replaced. In 1845 an American inventor, J. W. Starr, was granted a patent in England on a lamp consisting of a strip of carbon placed in the high vacuum existing at the top of a barometer tube. After an exhibition of a fixture holding 26 of his lamps, Starr died at the age of 25 on his return voyage to the United States.

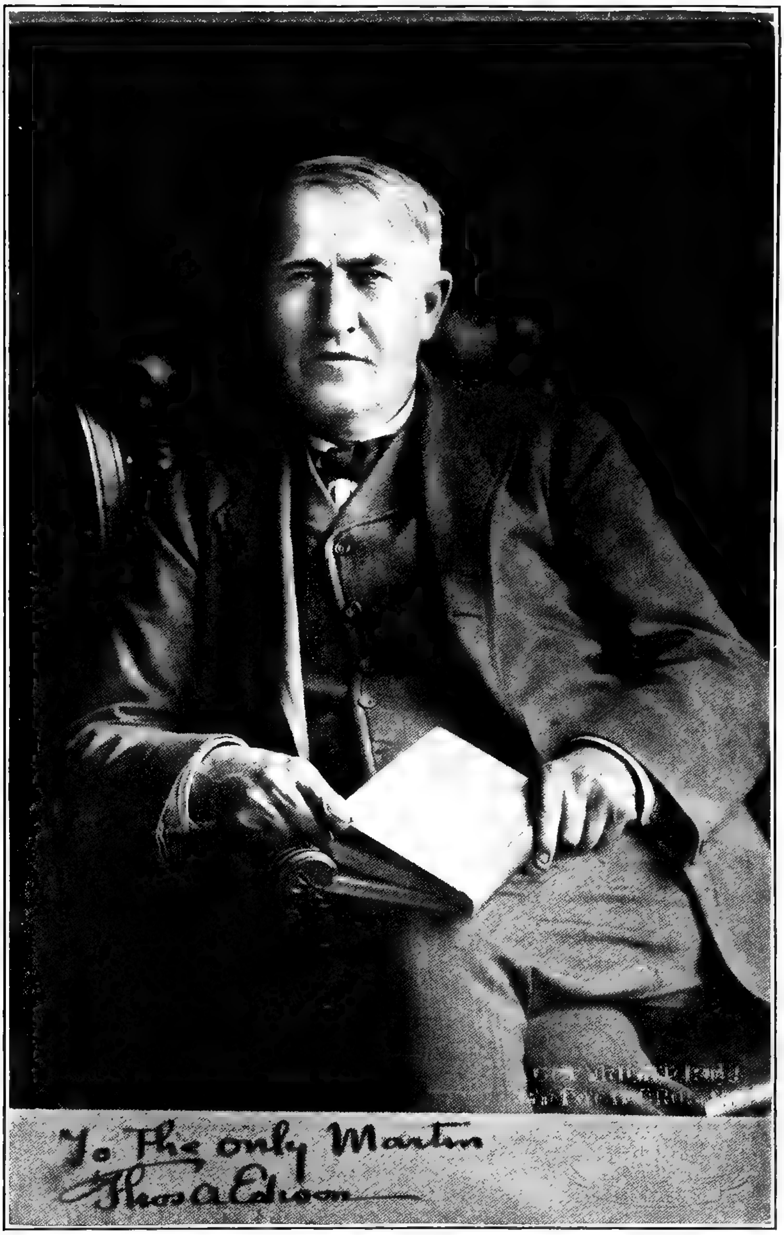
Just as, up to Starr's time, platinum had been the favorite material for lamp experimenters, so from now on for the next 30 years carbon was mostly used in the various efforts to produce a successful electric light. But the carbon rods used were not stable, and all sorts of devices were employed to replace within the globe of the lamp carbons that had disintegrated. None of these was commercially successful.

By the year 1878 the arc light had established itself, at least in the United States, as a successful street illuminant, and it was this fact which drew Edison's attention to the problem of subdividing it for use indoors. He decided that a system of interior illumination must be developed in which any one lamp could be lighted or turned out independent of all the others in the system. Arc lamps were all connected "in series," the current from the dynamo passing through them all successively, so that if anything happened to one lamp and it ceased to give light, the circuit was interrupted and all the lamps went out. Therefore Edison started out to invent a system in which the lamps were to be connected "in parallel"; that is, each lamp was to be connected to the two wires leading from the dynamo and there would be as many paths for the current to flow from the positive to the negative wire as there were lamps connected in the circuit. To make such a system practical, Edison decided he would have to make a lamp which would require much less current than any that had even been suggested up to that time.

With characteristic thoroughness, Edison tried out platinum filaments of various kinds and then experimented with carbonized paper. Then cotton thread was tried and the successful lamp was produced. The paper filaments were tried again and proved better than the thread. Arrangements were now made to produce the lamps on a commercial scale.

In a few houses and along the streets of Menlo Park the first hundred lamps were strung, and so great was the interest created by this wonderful experiment in the little, unknown village that over 3,000 people came out from New York on the last night of 1879 to see for themselves the new invention.

While the lamps were being turned out, experiments were continued to discover a better material for the filaments. In the early part of 1880 Edison happened to notice the little strip of bamboo used to bind a palm leaf fan and, as bamboo had not been tried for filaments, he decided to test it. The result was successful, and during the next nine or ten years all the Edison incandescent lamps, which ran into the millions, were fitted with bamboo filaments. Over 6,000 filament materials, including every known species of bamboo, were tried. In 1889 there came from the Edison laboratory an artificial filament made by dissolving cotton in a suitable liquid, the solution having a consistency about that of molasses being then "squirted" through a die into another liquid which hardened it into the thread-like form required. These squirted filaments were used in all incandescent lamps



THOMAS ALVA EDISON

A Heretofore Unpublished Photograph Presented to One of the Editors and Reproduced for this Work

up to the recent development of the tungsten filament, which is now practically universally used for incandescent lamps.

We must now retrace our steps to England and Michael Faraday to learn the beginnings of another vital piece of electrical apparatus—the electric motor. In 1819 Oersted had recorded that "the electric conflict acts in a rotating manner." In 1820 a monthly journal commissioned Faraday to write a history of electro-magnetism. Before doing any writing, he decided to repeat all the experiments made by others so that he could write about them with first hand knowledge. While thus engaged, on September 3, 1821, he made the discovery which resulted in the invention of the electric motor.

With his brother-in-law, George Barnard, Faraday was working in the labora-

tory of the Royal Institution. They had just set up on a table an apparatus consisting of a vertical glass tube closed at both ends by corks. In the lower end was a small quantity of mercury through which was thrust one pole of a bar magnet. From the upper cork, inside the tube, was loosely hung a stiff wire whose lower end touched the mercury. Several voltaic cells were connected to the circuit which ran through the hook supporting the stiff wire, along this wire to the mercury and back to the battery. Immediately the lower end of the wire began to move around the pole of the magnet. Faraday "danced about the table with beaming face."

There, before the delighted eyes of Faraday and Barnard, was established the fact that electrical energy can be translated back into mechanical movement — the germ of the electric motor of today. Of course these enthusiastic scientists could not even dream a tithe of the importance of their discovery. They were satisfied to know that they had developed something new in electrical experimentation. They kept on, however, and soon found that by reversing the direction of the current flow the direction of revolution of the wire was reversed. Or if they reversed the pole of the magnet and maintained the current flow in the same direction, the revolution of the wire was reversed.

In 1823 Barlow substituted a star shaped wheel for the stiff wire in Faraday's experiment and secured continuous rotation. In 1838 Jacobi built a boat which attained a speed of four miles per hour when driven by an electric motor. Professor Page, of the Smithsonian Institution, Washington, D. C., designed a motor, or "electro-magnetic engine," in which iron plungers were alternately sucked into solenoid magnets arranged on opposite sides of a "working beam," like those on side wheel steamboats, the motion being transmitted through a crank to a fly wheel. This engine, placed on a car, made a ten-mile trial run between Bladensburg and Washington on tracks in two hours.

As was the case with the arc light, the development of the electric motor was slow because of the expensive source of current necessarily involved in the use of voltaic cells of battery. The British Institution of Civil Engineers, in 1857, having discussed the possibility of producing a horse-power with less than 45 pounds of zinc, decided that until this was a fact the only practicable source of power was coal and the steam engine.

About 1870 engine-driven electric dynamos reached a point of development which assured a constant and cheap supply of electric current. The electric motor promptly began to develop when it was found that the dynamo and the motor were the same machine. In the case of the dynamo, mechanical effort is applied to produce electrical energy, while electrical energy supplied to a motor produces mechanical power. In the early motors the principal defects were found in the coils of wire which moved between the poles of the magnets. Siemens, Gramme, Edison, Eickemeyer and others improved this moving part until we have the motor with the modern armature.

The wonderful electric motors of today, built in all sizes from that of a watch to those big enough to operate a steel mill, little resemble in appearance Faraday's experimental apparatus which demonstrated the principle of "electro-magnetic rotations," but they owe their existence to the thoroughness of this pioneer investigator.

One of the very earliest pioneer investigators in the electric railway field, which was destined to be the largest commercial user of the electric motor, was Thomas Davenport, a blacksmith, of Brandon, Vermont. He undoubtedly had read or heard of Faraday's discoveries and conceived the idea of applying the electric motor as the power to move a vehicle. It is probable that he began his experiments about 1834, for we find that in 1835 Davenport had built a working model of his electric car which ran on a circular track of small diameter. This was exhibited at Springfield, Mass., and at Boston. During six years of work Davenport is credited with having designed over 100 forms of motor, some of which were used to drive printing presses and other machinery. He obtained a broad United States patent on his invention, but, as he was something like a half century ahead of his time, his work was not appreciated at its true value and nothing practical came of it. The model of his electric railway was dis-

covered years afterward and formed the subject of an interesting article in the *Electrical Engineer*. Davenport used the track rails to supply current to the motor on the car, the wheels on either side being insulated from each other. The motor was electrically connected by wires in contact with the car wheels.

Electric cars operated by voltaic cells carried on them were tried out by several experimenters, but the cost of current was prohibitive. A Scotchman named Robert Davidson, in 1838, operated such a car between Edinburgh and Glasgow at four miles an hour. The car devised by Professor Page in 1851 also used primary batteries. In 1840 a patent was issued in England which covered the use of the rails as conductors and another English patent, issued in 1855, described the overhead trolley line practically as we know it today. However, as the primary battery could not compete with the new steam railroads, the next twenty years contain no record of progress in electric traction. The successful development of the steam driven electric dynamo provided a cheap and flexible source of energy and at once interest was revived in the application of the electric motor to transportation. George F. Green, of Kalamazoo, Mich., in 1875, made a model electric railway operated by batteries; but, when he found that a dynamo was necessary for the commercial success of his idea and he was too poor to build one, he abandoned his experiments.

At the Berlin Exposition of 1879 Siemens & Halske operated an electric railway about a quarter of a mile long. An electric locomotive drew three cars with a capacity of about 20 people. A Siemens dynamo supplied current which was transmitted through an insulated rail, laid between the track rails, to a similar dynamo mounted on the locomotive and operated as a motor. This is the prototype of the third rail electric railway systems of today. In the United States the development of electric traction into a practical utility began about the same time through the labors of Stephen D. Field, Edison and Frank J. Sprague.

Although Edison was busily engaged in perfecting the incandescent lamp and in trying to increase the efficiency of his dynamo, he found time early in 1880 to build a little electric railway about a third of a mile long at Menlo Park. On this he demonstrated successfully that a dynamo of 90 per cent efficiency could be built and that it could be operated as a motor. A locomotive drew three cars over a light, unballasted track at speeds which ultimately reached 40 miles an hour. Numerous accidents occurred during these experiments, and many amusing stories are told of the terror of staid men of affairs who were invited by Edison to tempt fate by a ride on his electric railway. As in Davenport's system, the rails were used as conductors and were insulated by tar paper laid between them and the ties. The locomotive carried an Edison 12 horsepower generator mounted on its side operating as a motor. Through belts and pulleys it was connected with the axle of the locomotive truck. Edison devised a resistance coil to lessen the jar of starting when the full force of the current was suddenly turned into the motor. This was the forerunner of the controller used on all electric cars today. Just as commercial success seemed to be in sight Edison was thrown into interference in the Patent Office with Stephen D. Field. This led later to the formation of the Electric Railway Company of America which acquired the patents of both contestants.

At the Chicago Railway Exposition, in 1883, the Electric Railway Company of America exhibited an electric locomotive named "The Judge," after Stephen D. Field's brother, Chief Justice Field. During the two and a half weeks of the exposition this locomotive hauled about 25,000 passengers. Later at other expositions "The Judge" was instrumental in spreading the electric railway propaganda, but the commercial results of the efforts of Edison and Field were not what they had good reason to expect.

The real beginnings of the electric railway industry are properly credited to the pioneer work of Frank J. Sprague, who, early in 1887, began the installation at Richmond, Va., of a complete system. This contract comprised "the building of a generating station, erection of overhead lines, and the equipment of 40 cars, each with two 7½ horsepower motors on plans largely new and untried." The overhead trolley system under a pressure of 450

volts, with the track rails forming the return circuit, was used. In this work Sprague developed, among other important advances, the feeder system of supplying current to the trolley wire and the "bond," or form of copper cable, used to connect electrically the track rails at their joints in order to lower the resistance of the return circuit. While Dr. Hopkinson, in 1881, had established the groundwork for a system of "series-parallel" control, Sprague worked this out to practical success and produced a controller which enabled him to start his cars slowly and then at increasing speed. Just as in the modern trolley car, the motors on the Richmond cars were carried on the trucks and geared to the axles.

The necessity for transmitting electric current to considerable distances from the generating station and the limitations of the direct current for this purpose, owing to the losses in transmission or the prohibitive expense of the large conductors required, led to the development of the alternating current generator and system which is now used to send current to points as far away from the source as 250 miles. William Stanley, Jr., at Great Barrington, Mass., in 1885, was the pioneer in this development. In brief, as distinguished from the steady pressure or voltage of the direct current system, the pressure in the alternating current system rapidly shifts from positive to negative in wave forms or cycles. In practice, these alternations are as rapid as 25 and 60 per second. By generating alternating current of very high voltage it was found possible to transmit electrical energy to great distances. But the devices and apparatus which were to be energized were not suited for safe use with such high voltages. The problem, therefore, was to devise a means of reducing this voltage to a practicable and safe point at the place of use. Using a modified form of induction coil, Gaulard and Gibbs, in England in 1883, made pioneer efforts to design such a device.

Stanley, however, was the first in the United States to achieve success with what he called a "converter," which we now know as a "transformer." The principle involved here is that if the high voltage alternating current is passed through a coil of wire a secondary current of much lower voltage will be induced to flow through another coil of wire in proximity to it. The proportions of the size of wire and number of turns in the coils control the pressure and quantity of the secondary current. The first transformers built by Stanley converted a primary pressure of 500 volts to a secondary pressure of 100 volts, and each had a capacity sufficient to supply secondary current to 25 sixteen candle-power incandescent lamps. Several stores and the local hotel were equipped with Stanley converters, and the skeptics who predicted that the whole thing would go up with a flash and a bang were surprised to see it work quietly and successfully.

No sooner was the Morse system of telegraphy proved to be a success and a commercial development than electrical experimenters began to try to transmit by its means other sounds than the click of the telegraph instrument itself. Charles Bourceul, a Frenchman, wrote in 1854: "Suppose a man speaks near a movable disk sufficiently flexible to lose none of the vibrations of the voice, and that this device alternately makes and breaks the current from a battery; you may have at a distance another disk which will simultaneously execute the same vibrations." In the light of today this reads a great deal like a description of the telephone as we know it; but Bourceul seems to have been content to express his idea in words, and no record exists of any attempt to try out such a device. Johann Philip Reis, a poor German school teacher, is the next telephone pioneer. He developed a telephone which would transmit, after a fashion, musical sounds, but only an occasional word of an attempted conversation. His transmitter consisted of a piece of sausage skin, used as a tightly stretched membrane, to the center of which a bit of metal was attached. A contact spring was arranged to touch this metal very lightly. Reis' receiver was based on a discovery of Professor Page, of Salem, Mass., who found that an audible click occurred in the core of an electro-magnet when it was suddenly magnetized and demagnetized. The receiver devised by Reis was mounted on a sounding box and had a knitting needle for a core. Having established a proper electrical circuit between the Reis transmit-

ter and receiver, it was found that when a musical sound was made the membrane vibrated and this vibration was transmitted to the receiver where the knitting needle core gave off a series of clicks at the same rate. Its lack of ability to reproduce the "quality" of sounds made the Reis telephone a failure as a transmitter of speech.

In 1876, at the Centennial Exposition at Philadelphia, was publicly shown a successful telephone which would transmit not only musical sounds but human speech. It was the invention of Alexander Graham Bell and marks the beginning of an epoch in human progress. Dr. Bell, by education and experience, was well prepared for the rôle of telephone inventor. He had spent years in the study of the laws and physics of sound and the human voice in connection with his work of teaching deaf mutes to speak. He also had taken a great interest in Morse's telegraph and several years previous to his invention of the telephone had developed a system of multiplex telegraphy. In his application for a patent on this system he included a claim covering an early form of telephone. During the famous telephone patent litigation this early telephone, while imperfect in many respects, actually did transmit speech. The instrument shown at the Centennial embraced many improvements, and in a still later form the membrane, which had the defect of absorbing moisture from the air, was replaced by a thin disk of iron or "ferrotype plate." The distinctness of transmission also was greatly improved by including a shallow air chamber between the iron disk and the hearing orifice. All these features are included in the telephone as we know it.

While Sir Humphry Davy and other experimenters had demonstrated that the electric arc would melt most of the then known elements, including platinum, and while it also was known that the passage of an electric current through a conductor generated heat in the conductor, nothing definite regarding the relation between heat and electricity was established until 1842, when an Englishman named Joule carefully studied the subject and established what we know as "Joule's law." He first satisfied himself that, however small the current flowing in any length of conductor for even the shortest time, heat always was produced. By measurements made with instruments of his own devising, Joule finally proved that "the heat generated in a wire is proportional to the square of the amount of current flowing multiplied by the resistance of the wire and the time the current flows." The successful operation of all our modern electric heating devices, such as electric ranges and irons, as well as the great industrial processes dependent upon the electric furnace, is based on the invariable working of Joule's law.

Siebeck, of Berlin, discovered in 1821 that electric current could be produced by the contact of dissimilar metals, whose ends were soldered together to form circuits, provided their junctions were maintained at a certain difference of temperature. His experiment was made by soldering together a bar of bismuth and a bar of copper in the form of a hollow rectangle. When heat was applied to one of the junctions a current of electricity was produced. When the other junction was heated the current generated flowed in the opposite direction. He called these "thermo-electric" currents, the combination of the two metals a "thermo-electric couple" and the separate metals or substances or metals "thermo-electric elements." He found by experiment that a large number of substances could be used to form thermo-electric couples and arranged them in a series in the order of their thermo-electric powers. Although others, including a number of experimenters in our times, have followed the trail blazed by Siebeck no extensive commercial developments of his device have borne fruit.

Ohm's law, "C equals E divided by R," is often called the basic law of electricity. It was established in 1827 by Dr. G. S. Ohm, of Berlin, as the result of mathematical computations verified by experiment. It is as follows: "The current strength in any circuit is equal to the electro-motive force divided by the resistance." That is, the quantity or number of amperes in any electrical circuit is equal to the pressure or number of volts driving it through the circuit against the resistance to the passage of the current offered by the circuit. While this law is fundamental

and universal it applies only to direct currents. Another law is necessary to express similar relations for alternating currents.

Electrotyping and electroplating were invented or developed in England by Dr. Jacobi, in 1831; Messrs. Elkington and Barrett, in 1838; and Wright at a somewhat later date. These inventions, more properly and scientifically described as electrolysis, while of great industrial importance in themselves, led to the invention at a later date of that extremely valuable device, the electric storage battery. The Frenchman, Planté, in 1859, made a storage, or secondary, battery of lead plates immersed in dilute sulphuric acid. The action and reaction taking place in a storage battery are thus described: "By the passage of an electric current through the acid, electrolytic decomposition takes place and, by a process called 'forming the plates,' which consists substantially in sending a current for a considerable length of time in one direction and then passing it through the cell in the opposite direction and repeating this change of direction many times, the lead plates become changed; one of them becomes finally coated with lead peroxide and the other with finely divided metallic lead. If now, when in this state, the charging current be discontinued, the cell will act as an independent source of electric current and will produce a current which will flow through the cell in the opposite direction to that of the current which was required to charge it."

The chemical reactions which take place in the charging and discharging of a storage battery are of the most complicated character and still constitute a subject of discussion. At this point it is well to note a remark of Dr. Edwin J. Houston, who said: "A storage battery cannot any more properly be said to store electricity than a music box can be said to store sound when mechanical power is applied to wind its driving spring. What the storage battery actually stores is the energy of the charging current. It acts as a device whereby energy is stored up by effecting chemical decomposition, such energy being transformed from mechanical energy to chemical potential energy. In discharging the storage battery this chemical potential energy becomes liberated and appears as electric energy, just as it does in the voltaic cell."

Faure, in 1880, greatly improved Planté's original battery. In subsequent years Charles F. Brush and others in the United States made numerous improvements in details and processes of manufacture. Among the latest of the notable inventors who have turned their attention to this important device is Thomas A. Edison, who has developed and commercialized a storage battery of lighter weight which eliminates the lead plate. The modern storage battery, without which the submarine boat could not operate, occupies a most important place among electrical inventions.

The electrical scientist has had constantly before him the problem of "cold light," or a form of artificial illumination which will resemble the light given off by the fire-fly. Our electric lights contain a large proportion of useless heat rays which, by means of some discovery in the future, may be turned into useful light rays. It may be that this will be brought about through the invention of a process for creating physical phosphorescence by means of molecular bombardment through the use of alternating electrical currents of unlimited high frequency and extraordinarily high voltage.

The careful study now being given to the electric furnace by eminent engineers and scientists, in the mechanical and chemical fields as well as in the electrical, may result in discoveries which will revolutionize certain industrial processes. There are literally hundreds of drugs, dyes and chemicals now being manufactured in what seems to be a very wasteful manner which may, in the near future, be produced quickly and very cheaply through the use of an improved electric furnace.

The physician and diagnostician will probably find an increasing use for electricity in the future. It is not unreasonable to hope that systems of careful electrical measurements, made perhaps with instruments now unknown, will provide more accurate knowledge of the human body and its vital organs both in health and in a state of disease. It may be, too, that systems of electrical treatment will be devised by which the germ of recognized disease may be killed before they

have an opportunity to harm the human body.

We have come to regard the telephone as an instrument closely approximating perfection. Is it possible, then, that we may some day find attached to the telephone a device which will enable us to see the person with whom we are conversing?

SUMMING UP AT THE PRESENT TIME

In this day, when electric service in its broadest sense touches the daily life directly or indirectly of every inhabitant of the United States, it seems idle to speculate on what would happen if the armature of every generator in use suddenly stopped. The imagination, projected into the contemplation of such a state of affairs, readily would see a cessation of every activity to which we are accustomed except, for a time, the operation of steam railways. Over one hundred million people would be unable to use the telepnone, the telegraph, the wireless, the ocean cables, the trolley cars. The majority of our factories could not run after the daylight hours until illuminating gas was installed, and then the demand for gas would be such that it would require years to provide it in sufficient quantities. Our residences would be illuminated by candles as long as there were any to be had. Briefly, our business and social life actually would come to a standstill with all the perils and calamities incident to dark streets and the inability to communicate with each other quickly.

Although imaginings of this kind may seem fantastic, yet their setting down serves to emphasize the great boons which electric service has conferred on us, the importance of the generic functions which it performs and our almost universal dependence upon it for the proper conduct of our daily social and business life. We have come to accept all these boons as a matter of course and to assume without question that "the experiments of yesterday are the necessities of today." It is quite probable that the great majority of young men who will reach the voting age this year have never seen a horse car.

Having thus reminded ourselves of the importance of all that electricity does for us, what is to be said of the pioneer inventors, financiers and manufacturers whose early faith, unflagging courage and dogged persistence made it possible? The majority of them have, as their only reward, the consciousness of a vital public service performed. Many, of course, have achieved worldy success as measured in dollars and cents and not a few have reached the highest pinnacles of scientific attainment.

But let us not forget the men of vision and faith, such as those who financed the early telephone experiments of Bell, the man who advanced $40,000 to Edison to build an improved "stock ticker" or the manufacturers behind Sims who made it possible for him to design and build a high-speed engine suitable to drive dynamos for incandescent lighting. The names even of most of these adventurous pioneers of faith plus money have been forgotten, but without their aid at the time that most of our epoch-making inventions were conceived, it readily may be imagined that the discouraged inventor or experimenter might have been driven by the very necessities of existence to abandon his efforts and turn his hand to something sufficiently practical to enable him to live. Many a time did Edison have to stop his experiments for lack of funds, ask for a job as telegraph operator and save his salary until he had enough to get the apparatus he needed. The trials and tribulations of Elias Howe, inventor of the sewing machine, were no more severe than those endured by Acheson while perfecting his electric process for making carborundum.

Hundreds of other experimenters were obliged to follow along the same thorny paths until they arrived at a point where their devices had been developed into something demonstrable to the man with the necessary money. Therefore let us do all honor to those, known and unknown, who backed their faith with their cash and enabled the inventors to give us all that we have today of progress, civilization and comfort.

In considering the wonders performed by the electrical industry the most striking feature is the rapidity of its development. Every commercial use of the electric current, except the telegraph, has been conceived, perfected and given to our service

during the past forty years. At the Centennial Exposition in Philadelphia, 1876, the telephone and the arc light were publicly shown to the people at large for the first time. Both, as commercial enterprises or practical utilities, were in the embryonic stage. Many skeptics asserted that neither would ever amount to anything except, perhaps, as toys. The incandescent lamp was as yet unborn. The trolley car was still Holmes' fantastic "broomstick train."

In 1877 the total investment in commercial electrical enterprises in the United States was about $50,000,000, and all this was in telegraphs and ocean cables. In contrast, consider that the investment today in electric lighting, power and traction companies alone is represented by securities estimated at close to $7,000,000,000. Add to this the increased capital used in the telegraph companies, that employed in the telephone industry, in electrical manufacturing, in isolated plants and for miscellaneous purposes and we arrive at a stupendous total which reliable estimates place at near $25,000,000,000.

Perhaps a more easily understood picture of the vastness and importance of the electrical industry may be gained if we look at figures which show us what the people of the United States have paid out in 1917 for electric service of various kinds: For telegraphy of all sorts, $175,000,000; telephony, $425,000,000; central stations for all services performed, $500,000,000; electric railways, $775,000,000; isolated plants, $150,000,000; electrical manufactures, $600,000,000; a total of $2,625,000,000. Thus, these figures indicate an average expenditure for electric service during 1917 of about $25 per capita for every inhabitant of the United States.

If measured in terms of convenience, economy, comfort, safety and energy conserved in transportation, manufacturing, social intercourse and the domestic operations of housekeeping it is possible to figure a return on this average expenditure of $25 per capita many fold that obtained in the purchase of any other commodity whatever.

The contribution of electricity to the ease and comfort of living is made with so little effort and at such a minimum cost that it is at the command of almost every one. The universality of electric service is such that it has come to be taken as a matter of course. No modern landlord would think of erecting a dwelling without equipping it for electric service, primarily because he knows the values of that service, and in the second place he is well aware of the added renting value to him of electrically wired apartments and dwellings. Therefore, the modern landlord very sensibly regards electric wiring as an investment—not an expense.

At the time of the Centennial Exposition, 1876, the United States was in a receptive mood for the acceptance of innovations and inventions that seemed to spell progress. In the light of the present there can be no doubt of the vast good accomplished by this exposition in educating our people to expect and accept improvements and advances along any line that affected their work or their home lives.

The vast and complicated problems of the reconstruction period following the Civil War practically had been adjusted, the financial status of the country had been re-established, the surviving soldiers on both sides had been gradually re-absorbed into the civil body politic and the time seemed ripe for the advent of the inventor and experimenter, even though they labored in new and unknown fields. The people were more ready than ever before to heed and appraise innovations that promised progress.

The advance of invention during the nineteenth century, although practically halted during the Civil War, already had given to our people many devices of great and permanent value. The sewing machine had established itself as a household necessity, largely through the efforts of a country-wide house to house canvass by ingratiating salesmen. The farmer had been shown the value of the horse-drawn reaper, and the threshing machine was becoming known. In the large cities gas had established itself as a means of illumination. Steam power was being employed to drive looms, printing presses and other machinery. The bicycle was taking the country by storm, and the embryonic automobile was here and there being tried out by death defying inventors. Processes for vulcanizing rubber and galvanizing

iron had been developed. Photography had made wonderful advances, and the prototype of the kodak had appeared in the so-called "detective camera." In the field of chemistry great progress had been made. New elements had been discovered, gases had been liquified and solidified and the range of useful heat and cold had been indefinitely extended. The miner had been provided with the safety lamp, the caisson was in every-day use by the bridge builder and anti-friction metal had been generally adopted for the bearing parts of machinery. Steam navigation was advancing with rapid strides and steam railways were growing at the rate of more than a thousand miles a year. The gigantic expansion of the iron and steel industry, begun some years before by the change from wood to coal in the smelting furnaces, was assured by the almost constant discovery of new ore bodies and the ever increasing demand for the finished product.

And what of electrical development at this interesting period of our national growth? It will italicize our appreciation of the marvels of electrical progress which had its beginnings at this time if we again remind ourselves that the telephone, the electric light, the trolley car, the electric railway, the storage battery, the electric motor, the phonograph, the wireless telegraph, the electric iron, the fan motor, the vacuum cleaner and many other household electrical devices did not exist in practical form. Most of the difficulties of the telegraph had been solved, and we were daily using ocean cables. But for these exceptions, the modern marvels of electricity were as a sealed book.

Looking back down the decade, it would seem as if the world had never known and probably never will know again such an opportunity for valuable discovery in a virgin field of effort. But we must remember that for many years prior to the commercial awakening which now had its genesis, a noble band of scientists and experimenters had been delving away in the realm of electricity and pure physics with the result that many of their discoveries have since been proved to be fundamental principles. That band of pioneers from Gilbert to Franklin and Faraday had developed an endless wealth of phenomena which now awaited the process of invention which alone could render them useful to mankind. So that, in speaking of the electrical progress which had its beginnings fifty years ago, it were better, no doubt, to refer to "utilization" or "application" rather than broadly to "discovery."

The tools with which the inventor now set to work were, from our present viewpoint, crude indeed. To be sure, his source of electric current was now the dynamo instead of the Leyden jar, and he had recording instruments of a sort with which to check his results and gauge his advances. It was now possible cheaply to convert mechanical energy into electricity in unlimited quantities. In Philadelphia a manufacturer of covered wire for bonnet frames adapted his process to covering wire for the transmission of the electric current so that the experimenter could now avail himself of a means to utilize electrical energy at a point distant from its source. Crude forms of rubber and glass afforded insulators.

And here again begins our wonderful cycle of electrical invention and development along commercial lines. To judge the effect of a single invention is at any time a most difficult task; and the problem becomes vastly complicated when inventions of the highest order crowd upon each other in rapid and bewildering succession. Suffice it to say that, in the inventive genius displayed, electrical progress during the past fifty years has not been excelled at any time in the world's history by that of any other advances in the arts and sciences. No class of inventors has given more of real value to such a large proportion of the world's inhabitants as have those who have labored in the electrical field.

CHAPTER II

THE STORY OF THE TELEGRAPH

ORIGIN AND GROWTH OF THE IDEAS WHICH LATER LINKED THE WORLD WITH SUBMARINE CABLES AND WIRELESS TELEGRAHY

IN the year 1844, at the time the Morse system of electric telegraphy was introduced, and fourteen years later, when Europe and America were joined by telegraph cable, great civic honors were accorded the scientific pioneers who perfected these systems of long distance instantaneous communication.

In the great speeches delivered by the gentlemen present at these memorable celebrations the main thread of thought—almost a prayer—running through the remarks of all speakers was that the telegraph would prove to be a harbinger of universal peace, friendship and civilization.

That the hopes of those who were here to welcome the advent of the telegraph have not in full been realized, surely should not be charged to some unsuspected quality or property of the new art; but rather should we understand that a wide enough span has not not as yet intervened between the date of discovery and our own times for the art to work out its true destiny.

As the investigator gropes back through the attenuated records of the past in search of the birth of the idea of the telegraph he is peplexed by the many attempts previously made to lay finger upon the genesis, the origin, of the telegraphic idea.

The inspired author of the Book of Job exclaims, in an interrogatory framed to suggest the impossible, "Canst thou send lightnings that they may go, and say unto Thee, here we are?"

Surely the scientists of our own times have given the answer, and we are now able to "send lightnings" where we will and when we will.

Were it sensible to attribute to speculative fancy the beginning of any achievement or accomplishment which should ultimately have practical value, then we may say that John Baptista Porta, an Italian prodigy (1575) has claims which entitle him to recognition in telegraph history. In one of his published works Porta says: "To a friend, that is at a far distance from us, fast shut up in prison, we may relate our minds; which I do not doubt may be done by two mariner's compasses having the alphabet writ upon them."

Von Guericke, of Magdeburg (1655) observed the transference of electricity through a conductor (a linen thread an ell or more long), antedating by twenty years the work along similar lines of Boyle, Newton, and Hauksbee, in England.

In 1726 Wood, in England, discovered that electricity may be transmitted through long metallic conductors, and twenty years later Dr. Watson, in England, actually transmitted electric impulses over a circuit two miles in length.

In the year 1753, Charles Marshall, of Scotland, sent to The Scot's Magazine a communication which contained the earliest recorded reference to an electric telegraph, and as the telegraph was the forerunner of all electrical activities, historians of electrical development in all civilized countries have in hundreds of instances

made reference to the article which appeared in the February, 1753, issue of this magazine.

The article states, in part: "It is well known to all who are conversant in electrical experiments that the electric power may be propagated along a small wire, from one place to another, without being sensibly abated by the length of its progress; let, then, a set of wires equal in number to the letters of the alphabet be extended horizontally between two given places parallel to each other and each of them about an inch distant from that next to it. At every twenty yards' end let them be fixed in glass or jewelers' cement to some firm body, both to prevent them from touching the earth or any other non-electric, and from breaking from their own gravity." The writer then goes on to explain his proposed method of operating the telegraph, whereby bits of paper bearing the letters of the alphabet are placed an eighth of an inch below suspended metallic balls at the receiving end and are attracted thereto as each wire is electrically charged from the distant station. Thus by observing the letters affected the receiving operator may form the words of the message transmitted.

After the publication of the "C. M." article nearly a quarter of a century elapsed before the first method of electric telegraphy was tried out; namely, that of George Louis Le Sage of Geneva. Moigno writing in 1852, Sabine in 1867, and Taylor in 1879, all state that Le Sage actually established his telegraph system at Geneva in the year 1774.

Le Sage's method of telegraphing was almost identical with that suggested by "C. M." in The Scot's Magazine, previously mentioned.

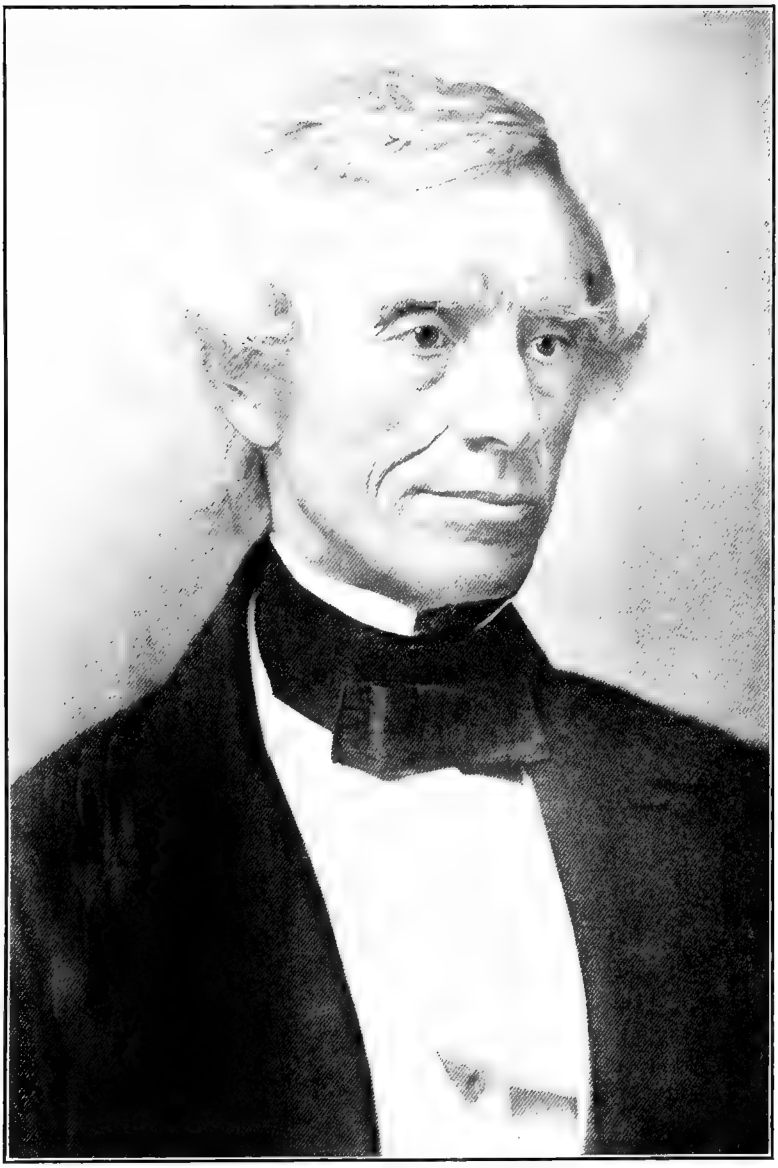
Then followed the telegraph experiments of Lomond, in France (1787), Claude Chappe, in France (1793), M. Reusser, in Switzerland (1794), Caballo, in England (1795), Salva, in Spain (1798), Soemmering, in Bavaria (1807), Schweigger, in Germany (1815), and Francis Ronalds, in England (1816).

In chronological order the next noteworthy attempt made to devise a system of telegraphy was that of Harrison Gray Dyar, of New York, in the year 1828. An account of Dyar's experiments is interesting; first, because his ill-fated invention was the first telegraph tried in America, and, second, because his system was the last of the long line of impracticable telegraphs which were dependent upon frictional electric machines as sources of current.

About the time Dyar was making his telegraph, Sturgeon, in England, and Joseph Henry, in America, were experimenting with electro-magnets—those obedient and tractable little helpmates which were destined to provide us with a real telegraph system and to revolutionize mechanical motion. Also, a year previously (1827), Ohm's Law had been announced.

Dyar's telegraph was of the electrochemical order, being operated by sparks produced by a friction machine, the sparks being spaced and regulated by a pendulum. There is no evidence to show that a receiving device was actually constructed, although Dyar proposed using a litmus-paper receiver as soon as the experiments made a transcribing device necessary. The experiments were conducted on Long Island over a great length of wire strung around a race course, and were satisfactory to the extent that he showed that sparks made at one end of the circuit could be observed at the other end of the wire. Presumably a metallic circuit was used, as no mention is made of the use of a ground return. In erecting the poles and wire, Dyar was aided by a Mr. Brown, of Providence, R. I., the legal side of the undertaking being in the hands of a Mr. Connell, of New York. As soon, however, as the experiments were well under way, Connell brought suit against Dyar for twenty thousand dollars, and, although the case was dismissed, John F. White, Dyar's patent attorney, notified him that Connell had secured a writ against Dyar charging conspiracy against the government for attempting to carry on secret communication between cities. Dyar forthwith abandoned his experiments and left the state in order to escape prosecution.

The important discoveries in electromagnetism made by Oersted, in Denmark (1820), Faraday, in England (1823), Sturgeon, in England (1824), and Henry, in America (1827), speedily brought to the



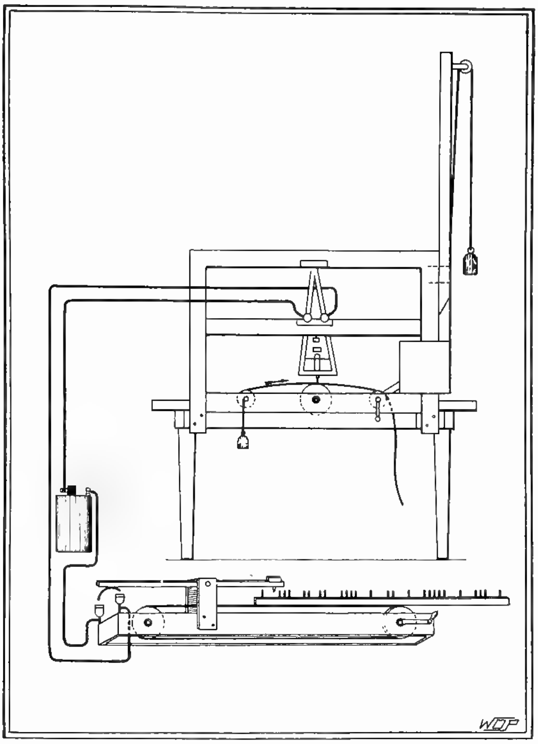
From the Collection of Col. R. C. Clowry.

PROF. SAMUEL F. B. MORSE

front entirely new ideas and agencies from which a practical system of telegraphy might be constructed. It is true, of course, that the operation of lines over considerable distances was not efficiently practicable until economical and reliable primary batteries were brought out. The primary cells introduced by John Frederick Daniell, in England (1836) and by William Grove, in England (1837) supplied the missing link and from that time onward practical telegraph systems were rapidly introduced and extended to meet social, governmental, and commercial requirements in all civilized countries.

In devising telegraphs the earliest use made of the principles of electro-magnetism was in connection with what is known as "the needle system." Baron Schilling, in Russia (1832) exhibited a method of signaling employing thirty-six deflecting needles. Gauss and Weber, in Germany, erected a metallic circuit about two miles long (1833), the received signals being in-

dicated by freely suspended needles. The practical development of this system was taken up by Steinheil, who, in 1837, had several miles of lines in operation in Bavaria. Steinheil devised a receiving arrangement employing bells of different pitch to indicate the letters of the alphabet. Steinheil's chief claim to fame rests upon his discovery made in the year 1837 that the earth could be used as the return portion on an electrical circuit.



The Port-rule, Morse's First Telegraph Sending Device

In England, in the year 1837, Edward Davy exhibited a telegraph system employing deflecting needles to indicate the received signals, and in the same year Cooke and Wheatstone, in England, procured an English patent (June 12) for a needle telegraph system employing six wires and five deflecting needles. (The American patent was granted June 10, 1840.)

We now arrive at the point where we may truthfully transfer the scene of telegraphic activity and invention from Europe to America.

During the past forty years various desultory attempts have been made purporting to establish the view that Joseph Henry, and not S. F. B. Morse, invented the system of electric telegraphy universally known as the Morse Telegraph System.

Henry's exemplary life and his profound writings vividly remind one of the life and work of his great English contemporary, Michael Faraday. Scientific history unreservedly accords to Henry the honor of being the first to devise electromagnets of a useful type; but there is plenty of evidence to show that in the beginning he did not think much about or concern himself with the development of electric telegraphy.

The thing Henry did which has misled some of his biographers was to suspend around the walls of the upper rooms in the Albany Academy a circuit consisting of a mile of copper wire in which was connected a primary battery and an electromagnet. A permanently magnetized steel rod was mounted on a pivot (like a compass needle) and situated in such position relatively to the electro-magnet that one extremity of the rod could play between the polar extremities of the magnet. Near the other end of the steel rod the gong of a small office bell was placed. When the current from the primary battery was sent through the circuit in one direction the rod was attracted into contact with one pole of the magnet, resulting in the opposite end of the rod striking the bell, thus giving a signal. When the current was reversed through the circuit the rod was attracted to the other pole of the electro-magnet, again causing the gong to be tapped. These demonstrations were made in the year 1832.

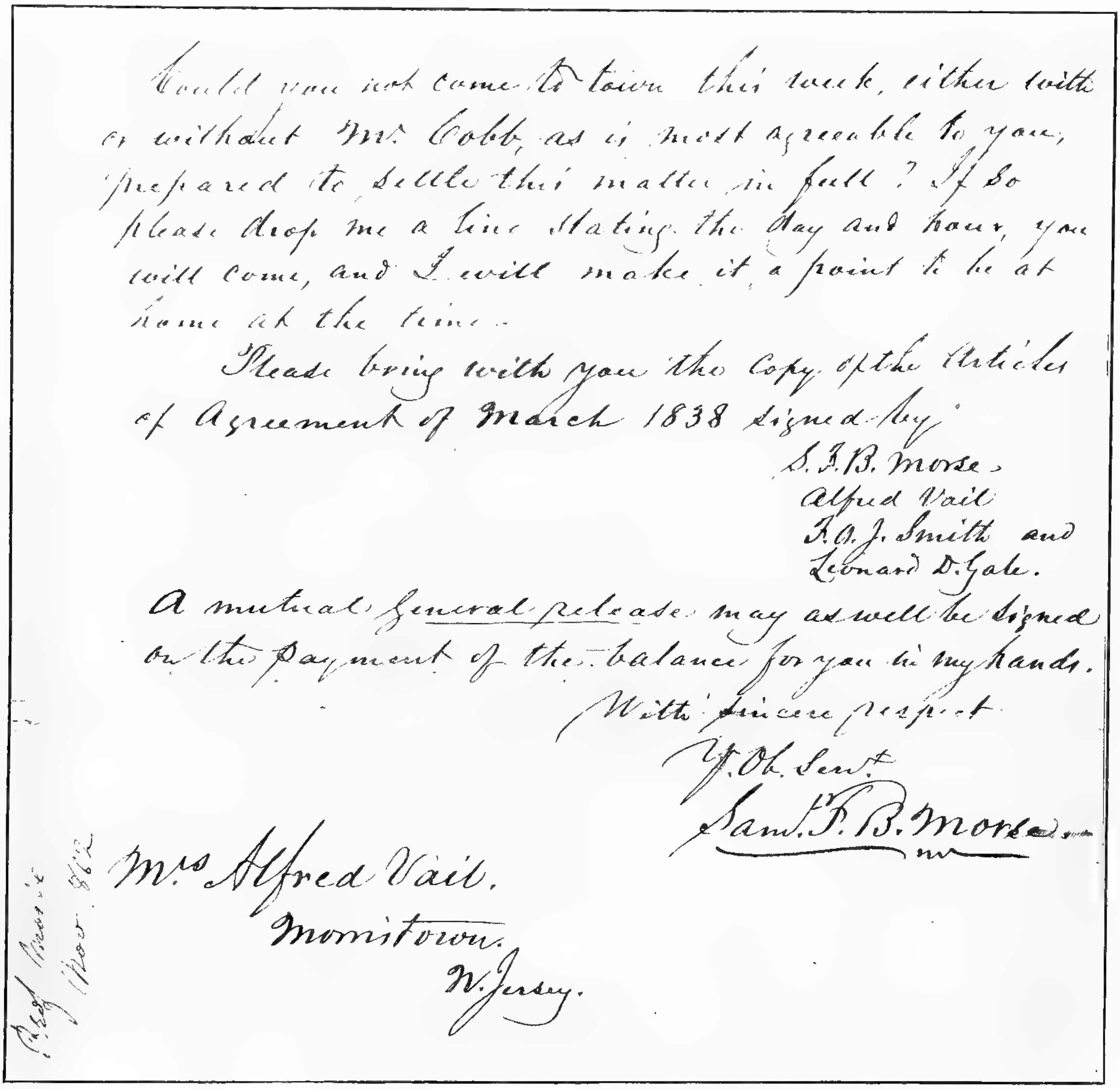
Morse's first idea of the telegraph came to him in the year 1832—he was then forty-one years of age—while he was on board the packet-ship Sully, sailing from Havre, France, to New York. A fellow passenger—Dr. Charles T. Jackson—one day at the dinner table discoursed upon the advances which had recently been made in the science of electricity, explaining the method of increasing the power of a magnet by passing electric current through convolutions of insulated wire wound upon a soft iron bar. The speaker stated that electricity was known to travel through

great lengths of conducting wire, practically instantaneously; whereupon Morse, who was present, propounded the question: "If the presence of electricity can be made visible in any part of the circuit, I see no reason why intelligence may not be transmitted instantaneously by electricity."

Morse was a portrait painter, not a scientist, and from his question, above quoted, it may be understood that his first vision of the possibilities of electricity disclosed to his practical mind the growing need for a system of transmitting intelligence now become possible because of discoveries and agencies already at hand.

Nothing short of inspiration could have given Morse his original broad conception of the ultimate utility of a system of instantaneous communication, and the way he overcame subsequent trials and discouragements while gathering up the elements of a workable system proved that he had unlimited faith, not only in ultimate technical success, but also in the meed certain to be awarded the first in the field with a practical system of electric telegraphy.

There were in the world at that time a number of eminent savants much better



Could you not come to town this week, either with or without Mr. Cobb, as is most agreeable to you, prepared to settle this matter in full? If so please drop me a line stating the day and hour, you will come, and I will make it a point to be at home at the time.

Please bring with you the Copy of the Articles of Agreement of March 1838 signed by

S. F. B. Morse,
Alfred Vail
F. O. J. Smith and
Leonard D. Gale.

A mutual general release may as well be signed on the payment of the balance for you in my hands.

With sincere respect
Y. Ob. Servt.
Saml. F. B. Morse.

Mrs. Alfred Vail.
Morristown.
N. Jersey.

Rec'd Morse's
Nov. 862

Reproduction of an Original Letter Written by Prof. Morse to Mrs. Alfred Vail of Morristown, N. J.

equipped than Morse was to solve the problem: In France, Peltier, Arago, De La Rive, and Ampere; in England, Faraday, Sturgeon, Cooke, Wheatstone, and Ronalds; in Russia, Jacobi, and Schilling; in Germany, Ruhmkorff, Lenz, Steinheil, Ohm, and Soemmering; in America, Joseph Henry, Page, Silliman, Day, and Frisbie.

In scientific history these men all are famous as the foremost scientists of their times, and most of them were in the heyday of manhood at the time the artist Morse by patient but persevering labor gave to the world the crowning electrical achievement of the century.

The fact that the five years intervening between October, 1832 (the date of the Morse-Jackson conversation on board the Sully) and November, 1837, were consumed by Morse in studying the requirements, and in constructing the first crude apparatus, but calls attention to the fact that there was an extended opportunity afforded others who may have been better informed electrically, or who may have had the means necessary to carry on experiments. That others did not, during this period, overtake and pass Morse in the march toward the goal of success points to the conclusion that Morse, and Morse only, had a true understanding of the entire problem.

When Morse arrived in New York from Europe, November 15, 1832, he at once set to work experimenting along lines suggested in numerous sketches and diagrams which he had recorded in his notebook while on ship-board, but owing to lack of funds and to inadequate shop facilities it was not until 1835 that he was able to assemble a working model embodying his ideas. By September 2, 1837, he had succeeded in building two sets of instruments, one for each end of a circuit, and on that date gave a public demonstration of his invention in the great hall of New York City University, where he was employed as a professor.

It was on this occasion that Morse had the good fortune to meet Mr. Alfred Vail, son of Judge Stephen Vail, proprietor of the Speedwell Iron Works at Morristown, New Jersey. Alfred Vail was then thirty years of age and had recently graduated from the University of the City of New York. Upon witnessing Morse's telegraph demonstrations in 1837, Vail became intensely interested, and learning that Morse was greatly in need of capital, and mechanical assistance, undertook to induce his father to furnish financial backing for Morse's enterprise, and himself agreed to take up the work of constructing improved apparatus at Speedwell.

Morse's *caveat* was filed in the patent office at Washington, October 6, 1837, and his application for letters patent was filed April 7, 1838.

On November 28, 1837, Morse advised the Secretary of the Treasury at Washington—with whom he had previous correspondence regarding the telegraph—that he had succeeded in operating a telegraph circuit ten miles in length.

From the year 1837 until 1842 Morse's time was taken up procuring patent protection in European countries, giving exhibitions of his system in the large cities in this country, and in perfecting details of the mechanism of the telegraph. Also, during these years a continuous effort was made to induce the American government to make an appropriation to defray the costs of establishing an experimental line of telegraph between two of the eastern cities. In December, 1842, Morse was persuaded to make one more application to Congress, and, on March 3, 1843, a bill appropriating thirty thousand dollars to aid the enterprise passed through the House by a very close margin.

Plans were immediately made to construct a line between Washington and Baltimore, the conductors to be laid underground between these points.

Ezra Cornell, later the founder of Cornell University, was engaged to take charge of the conduit work, leaving New York for Baltimore on October 17, 1843. The conductors consisted of four insulated No. 16 copper wires inclosed in a lead pipe which was laid in a trench between the double tracks of the Baltimore and Ohio Railroad extending between Washington and Baltimore.

Early in the year 1844 it was discovered that the conductors in the pipe were badly mixed, after about ten miles of the underground system had been constructed. The

underground scheme was then abandoned and the wires strung on poles.

On May 24, 1844, the famous "first message," "What Hath God Wrought?" was sent over the line from Washington.

The Washington-Baltimore line was regarded, for a time, as government property, and on May 15, 1845, a charter was granted for the first private commercial telegraph line in America—The Magnetic Telegraph Company.

In the meantime in Europe needle telegraph systems, dial telegraph systems, and electro-chemical telegraph systems had been established; but as, later on, most of these methods of telegraphing were displaced by the Morse system, or modifications of the same, the Story of the Telegraph may reasonably be confined to the development of invention and progress in America.

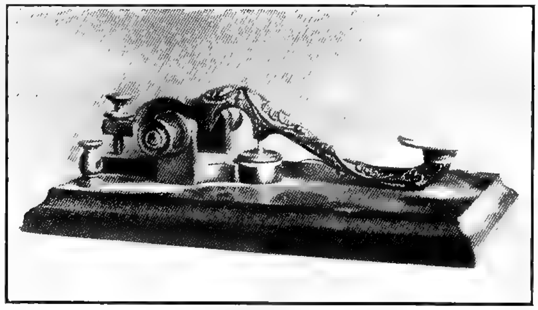
The success of Morse's first line created wide interest in the telegraph, and the construction of lines in many directions was soon begun. In 1846 a line was opened for service between New York and Boston, another between Philadelphia and Pittsburgh, and still another between Buffalo, New York, and Toronto, Canada; in 1847, a line between Troy, New York, and Montreal, Canada; in 1848, a line between Portland, Maine, and Calais, Maine, and many other lines.

In 1849 the House Printing Telegraph Company was organized, and constructed lines between New York and Boston and between New York and Philadelphia. A year later "House" lines were built between New York and Buffalo and between Buffalo and Cincinnati, the character of pole line construction showing great improvement over that of lines previously constructed. The "House" system was operated in opposition to the Morse lines.

In the year 1850 still another opposition company, known as the Merchants' Line, entered the field, erecting lines between New York and Boston and between New York and Washington. The system was based upon the electro-chemical telegraph inventions of Alexander Bain, of Scotland. Bain had applied for an American patent in the year 1849. After about three years of operation the Bain lines consolidated with the Morse lines, the combination taking the name "Union Lines."

In the year 1851 there were over fifty separate telegraph companies doing business in the United States, many of them operating under Morse's patents, others using then existing printing telegraph systems.

On April 2, 1851, Henry S. Potter was elected president of the New York and Mississippi Valley Printing Telegraph Company, the immediate predecessor of the Western Union Telegraph Company, of which latter company Mr. Potter was the first president.



Special Silver Telegraph Key used by Professor Morse

It may well be imagined that with fifty or more telegraph companies in the field, many of them operating in exclusive territory, the cost of telegraphing, together with the delay in transferring messages from one company to its connections, created a situation which had to be corrected if the new art was to have a fair opportunity to be efficiently useful.

Although it was not until 1866 that the headquarters of the Western Union Company was moved from Rochester, New York, to New York City, a movement was set in motion in 1851 with the object of bringing about consolidation of the various adjoining telegraph lines. Also, in 1851 the application of the telegraph to railroad requirements was begun. In that year the first telegraphic train-order was sent, on the Erie Railroad. Within two years thereafter the Erie Railroad had 497 miles of telegraph line in operation, with fifty-two telegraph stations, and employed sixty-five telegraphers.

The rapid extension of the telegraph which followed to meet railroad and com-

mercial requirements attracted to the work many bright minds, and during the years intervening between 1851 and 1858 many improvements were made in telegraph apparatus. In 1851 the first automatic repeater was invented, by C. S. Buckley. In 1852 Moses G. Farmer experimented with double telegraph transmission over a single wire. In 1855 George F. Milliken, of Boston, introduced the first spring-jack switch-board, and in the same year George M. Phelps and David E. Hughes perfected new printing telegraph systems. In 1857 Farmer and Woodman introduced an improvement in automatic telegraph repeaters.

In the year 1857 the first attempt was made to lay a submarine telegraph cable between Europe and America, and although the first efforts failed of success, the experience gained proved of inestimable value in a later enterprise.

The first submarine cable laid was that between Dover, England, and Calais, France, in the year 1851. Two years later a six-conductor cable was laid between England and Ireland. In the year 1856 American and British naval officers made extensive soundings in the Atlantic Ocean between Europe and America for the purpose of charting possible routes for cables to be laid between Europe and North America.

During the year 1856 a cable was laid between Newfoundland and Nova Scotia, a distance of eighty-five miles.

In the month of August, 1857, the first attempt was made to lay a cable across the Atlantic. The venture failed, owing chiefly to the employment of imperfectly designed cable-laying machinery. Three hundred and thirty miles of the cable was lost in the sea.

In the summer of 1858 another attempt was made to forge the link between Europe and America. The expedition met with several mishaps, but on August 5 of that year the completed cable was ready for test between Trinity Bay, Newfoundland, and Valentia, Ireland, a distance of 1,960 miles on the surface of the ocean, the actual length of the cable being 2,267 miles. The extra 307 miles of cable was taken up in following the hills and dales of the sea bottom.

After three weeks of fairly satisfactory operation, chiefly of an experimental nature, this cable failed.

In the year 1865 Cyrus W. Field, of New York, employing the famous British ship Great Eastern, made a brave but unsuccessful attempt to establish the much desired telegraphic connection across the Atlantic. When 1,186 miles of cable had been passed overboard the strand broke, and its recovery was, for the time being, abandoned.

CYRUS W. FIELD
The Creator of the First Atlantic Cable

In 1866 Mr. Field reorganized the enterprise under the name of The Anglo-American Telegraph Company, and once more to the Great Eastern the task was assigned to complete the job. The route taken in crossing the Atlantic was about twenty-seven miles north of the line along which the 1865 cable was laid. The cable extended between Foilhommerun Bay, Ireland, and Heart's Content, Newfoundland. The Great Eastern made the trip in fourteen days, sailing 1,909 miles and laying 2,113 miles of cable. This was the first satisfactory cable laid across the Atlantic, and in cable circles July 27, 1866,

is known as the date upon which submarine telegraphy became an accomplished fact.

The second Atlantic cable was made up of the abandoned section of the 1865 cable spliced to a new section. The work was done by the Great Eastern in September, 1866.

At the start both of these cables were worked at a speed of six words per minute, but improvements made in terminal apparatus, together with increased skill on the part of the operating staff, shortly resulted in a speed of seventeen words per minute.

In later years the employment of Lord Kelvin's siphon recorder as a receiving instrument, with other improvements, ran the speed of cable operation up to forty words per minute. Today a speed of forty-five words per minute simultaneously in each direction over a cable is the ordinary gait, while certain cables which are equipped with electrical amplifiers of recent invention are carrying 135 words per minute.

Going back for a moment to where we left off in the development of land line telegraph systems—the year 1858—the next important period was that of the civil war in the United States.

On March 15, 1861, overland telegraph communication was for the first time established between cities on the Atlantic coast and California, and many other lines north, south, east and west were opened to traffic.

The Northwestern Telegraph Company erected a line consisting of a Number 8 iron wire between Milwaukee, Wisconsin, and St. Paul, Minnesota, in the year 1862. At the various points where the wire crossed the Mississippi river watchmen were stationed to lower the wire into the river in order to prevent steamboats from breaking the strand as they passed up or down the river.


St. Louis and Missouri River

TELEGRAPH.

NOTICE.

Full Rates must be Charged in all cases for Information relative to the movement of Steamboats on the river.

R. C. CLOWRY, Sup't.

Ornate Copy of a Telegraph Notice Issued in 1859 when there were no Railroads West of the Missouri River

It was in the year 1863 that the original Morse patents expired. A year later several of the existing independent telegraph concerns combined under the name of the United States Telegraph Company.

In 1865 two new telegraph companies entered the field, namely, the Franklin Telegraph Company and the Atlantic and Pacific Telegraph Company.

In the year 1866 the United States Telegraph Company, together with other independent lines, consolidated with the Western Union Company, and in that year the general offices of the Western Union Company were transferred from Rochester to New York City.

During the period of the civil war the telegraph was used for the first time in this country in military operations. For the first time in history the value of the telegraph to armies in the field was demonstrated during this conflict. Comparing Sherman's operations in 1864 with Napoleon's plans of 1812 to invade Russia, the great benefits of a ready means of instantaneous communication between points remotely separated were evidenced, and it is to the point to observe that owing to antiquated methods of communication it required nearly six months for Napoleon to concentrate a force of 500,000 men to enter Russia via Poland. Lack of an adequate means of communication in advance and to the rear was a handicap which spelled ultimate disaster for the French armies.

After 84 days' march and a costly battle, Napoleon entered Moscow, only to find that the country had been laid waste and the city of Moscow burned down. In the face of an approaching winter Napoleon retreated, and, chiefly owing to lack of communications, lost 450,000 men before reaching a base of supplies.

In the year 1864, with thoroughly organized telegraphic communications, General Sherman began his march into Georgia with 100,000 men; within three months he entered Atlanta. Reaching that point, Sherman was able to communicate with the commanding general 1,500 miles away and to plan his march to the sea, where, instead of meeting desolation, he found available plentiful stores and supplies provided for his coming—all through the medium of the telegraph.

During the period of the civil war the financial resources of the country had been so taken up with the prosecution of military undertakings that only a limited amount of new line was constructed. Also, some of the existing trunk lines had not been maintained witn a view to coming increase in traffic; and as it developed that during the period of reconstruction the telegraph was used extensively for social and commercial correspondence a situation was presented wherein additional wires would have to be strung over all main routes, or that American genius would forthwith have to invent systems making possible the transmission of more than one message over an individual wire simultaneously.

And, as always, American genius met the issue fairly and in a satisfactory degree.

Once more harking back a few years we find that in 1852 Moses G. Farmer, that earnest pioneer philosopher, had conducted experiments with a view to setting up apparatus capable of doubling the capacity of a single wire. Although Farmer did not attain complete success, he went far enough to start others working along the same lines.

Experiments with a similar end in view were conducted by Gintl, in Austria, and by Siemens and Halske, in Germany, in the year 1853; also by Stark, in Austria, and Bernstein, in Germany, in 1855.

It was not, however, until the year 1868 that a practical method of duplex telegraphy was invented. In that year Mr. Joseph B. Stearns, of Boston, brought out a workable system, which was first placed in service on the lines of the Franklin Telegraph Company between New York and Boston, and a year or two later on the lines of the Western Union Company.

The practical application of this invention at once doubled the capacity of all single wires so operated.

It has been stated that "coming events cast their shadows before," and as a momentous event closely related to the needs of the telegraph in the year 1869 it is apropos here to record that it was in that year that Thomas A. Edison—then a

youth of twenty-two years — arrived in New York City.

In 1872 Mr. Edison invented a chemical automatic high-speed system which made possible the transmission of a greatly increased number of words over a wire in a given time, and a year later Edison and Prescott successfully operated a quadruplex system of telegraphy over a circuit from New York to Boston. This system provided for simultaneous transmission of two messages in each direction over a single wire. American genius had not been found wanting.

The duplex and quadruplex systems have not only been of great value in increasing the capacity of lines for Morse operation, but have been successfully applied in further increasing the line capacity in connection with high-speed automatic telegraphy. The duplex principle forms a part of modern printing telegraph systems, permitting that lines operated as printer circuits may carry one message in each direction at a time simultaneously.

In the year 1876 the first underground pneumatic tubes were laid between the main office of the Western Union Company, in New York, and the telegraph office in the Wall Street district, and in 1877 two underground cables 2,200 feet long, with 30 conductors each, were laid in New York City for telegraph purposes. In 1879 Stephen D. Field first employed dynamos for the generation of electricity for telegraph purposes in place of gravity cells, then extensively used for this purpose.

Although the telephone arrived in the year 1876, it was not until twenty years later that telephone service had developed to an extent which made it a competitor of the telegraph to be reckoned with. The rapid increase of telegraph traffic during these years resulted in the telegraph being regarded as a fertile field for investment. Once more there was an epidemic of new telegraph companies, almost as widespread as that prevailing in the early fifties.

In 1879 an opposition company entered the field under the name of The Baltimore and Ohio Telegraph Company. In 1884 David Homer Bates, at that time assistant general manager of the Western Union Company, became President of the B. & O. Company. In 1887 this company had a total of 50,978 miles of wire in operation, extending from Maine to Texas by way of New York, Washington, Chicago, and St. Louis. In October, 1887, the B. & O. Company consolidated with the Western Union Company.

In 1879 The American Rapid Telegraph Company was organized with a capital of three million dollars. In 1883 the company had in operation about 15,000 miles of wires; on the trunk lines using the newly invented Foote and Randall high-speed chemical automatic system. The automatic system of operation was early abandoned in favor of Morse instruments, and in the year 1884 the American Rapid Company was absorbed by the Western Union.

In 1883 The Mutual Union Telegraph Company was organized with the very modest capital of six hundred thousand dollars. A year later the company's plant was leased to the Western Union for a term of ninety-nine years.

Still another telegraph company was launched in the year 1881, known as the Bankers' and Merchants' Line, with a capital of one million dollars. In September, 1884, this company was declared bankrupt, and in 1885 the property was taken over by The United Lines Telegraph Company, a newly organized concern. The United Lines Company, in turn, within a short time was taken over by the Postal Telegraph-Cable Company (first organized in the year 1881 and reorganized in 1883), which company has remained in the field up to the present time in opposition to the Western Union Telegraph Company.

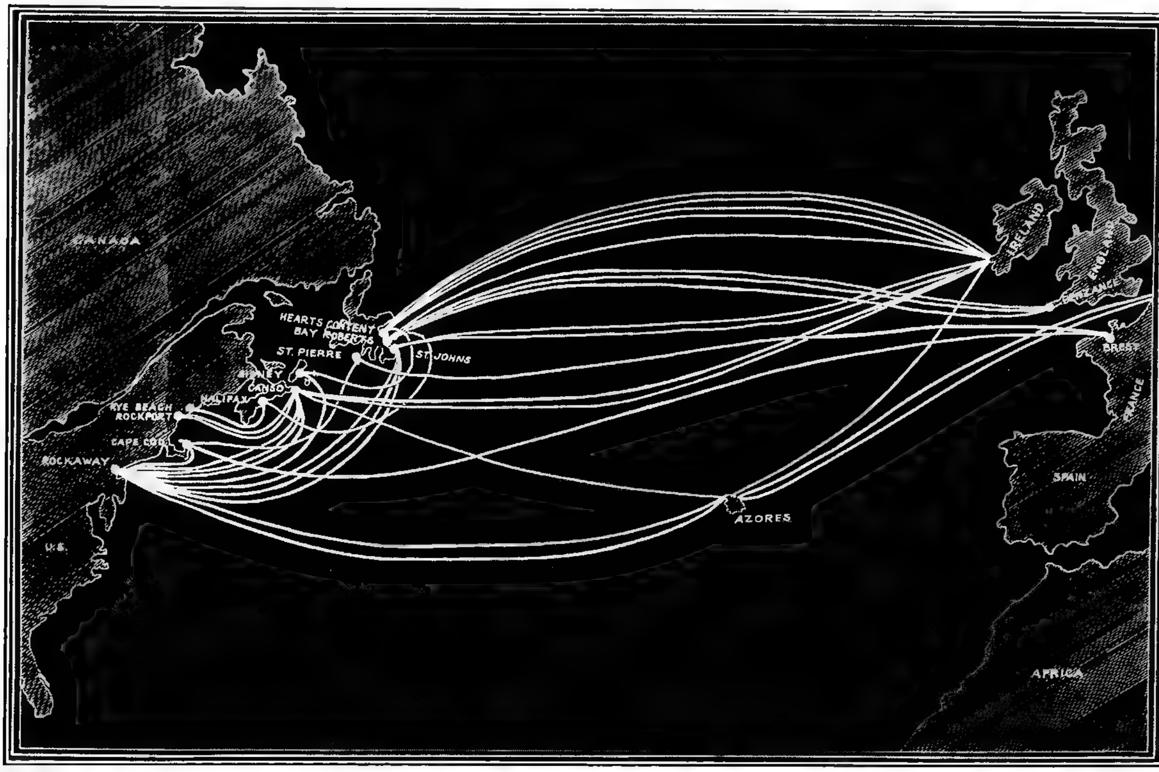
Dropping for a moment the story of land line telegraphs it may be well to revert to the account of the extension of submarine cables which followed the laying of the first successful trans-atlantic cable in the year 1866, previously referred to.

Telegraphic connection between Europe and America was not long left dependent upon the two strands which joined the two continents in the year 1866. Additional cables were laid in the years 1873, 1874, 1880 and 1894, the main sections extending between Ireland and Newfoundland.

The 1874 cable was the last cable-laying enterprise in which the famous ship *Great Eastern* was employed.

In 1869 and in 1879 cables were laid between the coasts of France and America.

The Commercial Cable Company laid two cables across the Atlantic in 1884, one



Showing Present (1918) Submarine Telegraph Cables and Routes between America and Europe

in 1894, one in 1905, and one in the year 1901.

Two submarine cables were laid between Germany and the United States, one in 1900 and the other in 1904.

At the present time (1917) there are seventeen cables in operation between Europe and North America.

It was not until the year 1903 that the Pacific Ocean was spanned by a submarine cable. In that year an all-British cable was laid from a port in the province of British Columbia, Canada, to Australia. Also, in the year 1903, the Commercial Cable Company laid an all-American cable between San Francisco and the Philippine Islands. In 1906 this cable was extended to Japan and China.

In 1866 a cable was laid between Punta Rassa, Florida, and Havana, Cuba, and in 1880 a cable between Galveston, Texas, and Vera Cruz, Mexico. Connection was made with South America in the year 1882 by means of a cable laid between New York, and Colon, Panama, thence across the Isthmus and along the west coast of South America. Since that time duplicate cables have been laid along all main routes.

At this writing, 1918, there are 290,000 miles of submarine cable in use, having been laid at a cost of $300,000,000, and in the waters of the globe forty-six cable steamers are employed in the task of repairing and maintaining these submarine lines.

As a reminder that sending four telegrams over one wire simultaneously, or hooking up two typewriters by a wire five hundred miles long, was not to be the ultimate of telegraphic achievement, in the year 1896 news despatches came over the cable from London announcing that an

Italian youth named Marconi had arrived in England with apparatus of his invention which made possible the sending of telegrams over short distances without the need of intervening wires.

In the years immediately following 1896 speculation was rife the world over as to whether or not connecting wires and submarine cables were doomed. Although wireless telegraphy has made great strides since 1896, it is apparent that it has developed a field of its own—a field of great and ever expanding usefulness; but, on the other hand, it is a fact that additional land wires are still being erected and additional submarine cables laid.

Wireless telegraphy may truthfully be said to have had its beginning when Clerk Maxwell, the great English physicist, about the year 1864, announced his mathematical deductions relating to the electromagnetic theory of light.

In the year 1888 Heinrich Hertz, in Germany, reaped the harvest by experimentally proving Maxwell's theories and announcing a method of producing controllable electro-magnetic vibrations.

In 1891 Branly, in France, discovered a practical method of detecting Hertz' waves at any point in space, and in the year 1894 Oliver Lodge, in England, constructed and exhibited various forms of the Branly detector in action.

In Italy, in the year 1895, Marconi experimented with the devices of Hertz and Branly and constructed apparatus capable of telegraphing over short distances without the use of connecting wires.

In 1896 Marconi, through the cooperation of Mr. W. H. Preece, chief electrical engineer of the British Post-Office Telegraphs, transmitted signals over a distance of one and three-fourths miles on Salisbury Plain.

In March, 1897, a distance of four miles on Salisbury Plain was covered, and on May thirteenth of that year communication was established between Lavernock Point and Brean Down, a distance of eight miles.

In America (1890-1897) many students of science were in touch with the discoveries being made in Europe, and it was during the latter year that the utilitarian American mind first sensed the commercial possibilities of the newly discovered method of transmitting telegraphic signals.

In September, 1899, during the International Yacht Races off New York harbor, the steamer *Ponce* was equipped with radio apparatus by Marconi for the purpose of transmitting reports of the progress of the race. Two receiving stations were equipped; one on the Commercial Cable Company's cable ship Mackay Bennett, stationed near Sandy Hook, and connected with a land line station on shore by means of an ordinary submarine cable; the other at Navesink Highlands. This demonstration, although not highly successful, brought the subject to the fore in this country.

In the year 1900 the first Marconi station at Cape Cod, Mass., was built, and a year later the station at Siasconset was completed. The intention was to communicate with ships at sea, later to be equipped with radio apparatus.

The crowning radio event of the year 1901 was the reception by Mr. Marconi, at St. Johns, Newfoundland, of the letter "S," transmitted as a test signal from his English station; this was on December 21, 1901.

Beginning in the year 1902, many improvements in radio apparatus were made by American inventors; notably Dr. Lee De Forest, Prof. R. A. Fessenden, Nikola Tesla, John Stone Stone, and W. W. Massie.

When first introduced commercially in this country radio telegraphy was exploited by a number of separate operating and manufacturing companies, and during the first seven or eight years the practices of stock jobbing and of organizing fake companies retarded the development of the new system.

However, as was the experience with land line telegraphy, all of these companies which had tangible assets ultimately consolidated with the Marconi Company, the major concern, and by the year 1912 the business had become a commercial reality. High power coastal stations have been erected, which now are capable of spanning the Atlantic and the Pacific oceans.

The fact that the World-German war, begun in the summer of the year 1914, necessitated the taking over by the Entente

naval authorities of all high-power stations for the purposes of the war temporarily interrupted extensive use of radio for commercial purposes, but is looked upon only as a setback by the operating company.

It is predicted that after the termination of the great war radio telegraphy will come into its own, and that a world service will be established which will vigorously compete with existing submarine cable lines. From the present viewpoint there is little probability that radio will in the near future prove a serious competitor of land line telegraph systems. The cable companies, too, regard the extension of radio operation rather as an aid or auxiliary than as an opposition service.

In the year 1913 Mr. Edward J. Nally, who had been Vice-President and General Manager of the Postal Telegraph-Cable Company, became General Manager of the American Marconi Company, and from that time onward the management and operation of the radio system passed into the hands of thoroughly trained telegraph executives.

In conclusion, we shall take up the story of land line telegraphy where we left off with it in the year 1883, at the time the reorganized Postal Telegraph-Cable Company entered the field in earnest, under the aggressive management of the late John W. Mackay.

One of the most common remarks made in uninformed circles in reference to the state of the art of telegraphy at the present time is that the telegraph stands today where Morse and his immediate successors left it fifty years ago. Nothing could be further from the truth than this. In fact, it may safely be said that nothing remains of Morse's original work except the sending key and the symbol code, or alphabet. Even the key has during the past fifteen years been used only to a limited extent.

Numerous technical improvements have been made in the design and arrangement of apparatus, and the fact that today eighty telegrams per hour are handled over a single outlet where fifteen years ago half that number in the same time was regarded as good performance, and that during the same period the time of transmission of a telegram between cities remotely separated has been reduced at least one-half, cannot but be admitted as convincing evidence that vast improvement has taken place.

It should be remembered that toll telephone service was opened for public use between New York and Boston in the year 1887 and between New York and Chicago in 1892; also in other directions and between many other cities prior to and subsequent to the year 1887; but notwithstanding that the telephone has carried an ever increasing volume of long distance traffic, telegraph message traffic has continuously increased to an extent which today taxes to the utmost the carrying capacity of the vast network of lines joining together every village, town, and city of importance in the country.

After the disappearance of the "House," "Hughes" and "Phelps" printing telegraph systems in the early days of telegraphy, ordinary Morse operation, with a few scattered Wheatstone circuits, held the field during a period of thirty years.

In the year 1907 the Barclay-Buckingham printing telegraph system was introduced on the lines of the Western Union Telegraph Company and for a number of years thereafter was quite extensively employed.

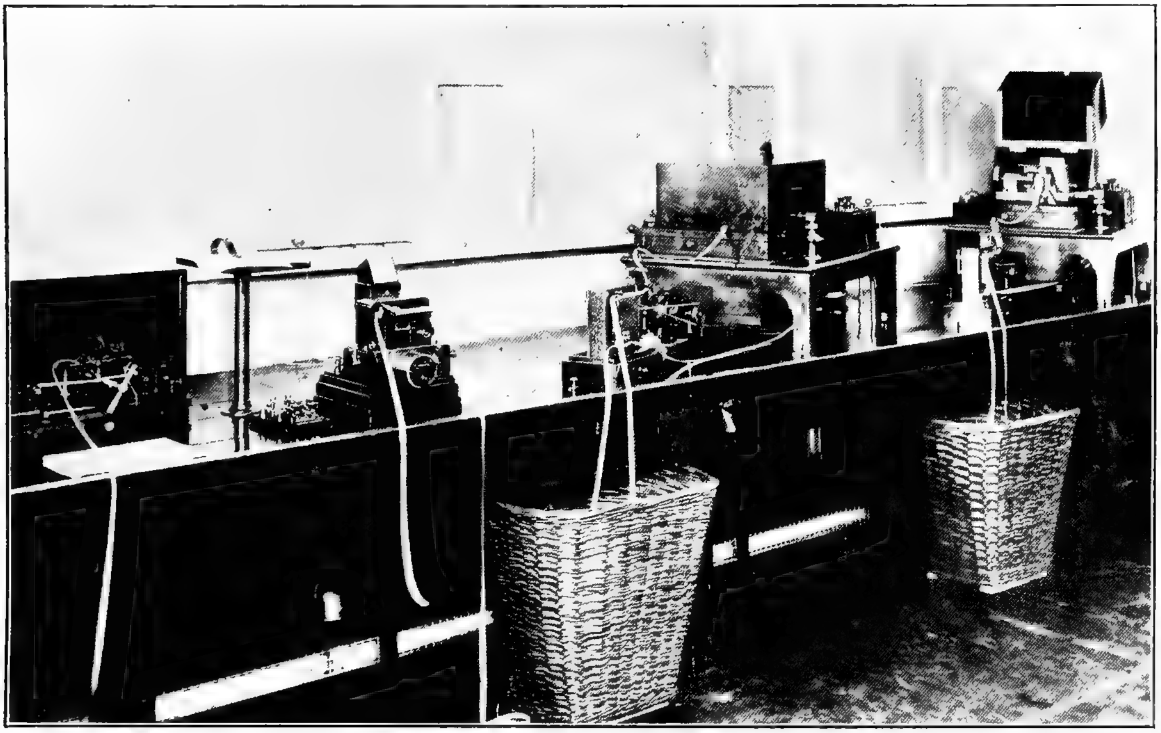
In the same year the Postal Telegraph Company experimented with the printing telegraph inventions of Prof. H. A. Rowland. The Rowland was a beautiful and ingenious system capable of transmitting eight telegrams simultaneously over a single wire, the received message being reproduced in typewritten characters in page form. At the expiration of a year or two the system was discontinued by the Postal Company because it was decided that it did not ideally meet existing traffic conditions.

Then followed the printer invented by John E. Wright, an old associate of Mr. Edison. The Wright printer permitted the transmission of one message in each direction over a single wire simultaneously. Mechanical difficulties and frequent circuit failures resulted in the printer being returned to the shops for further development about the year 1911. It has not since reappeared in commercial service.

In 1910 Messrs. Krum and Morton introduced a comparatively simple duplex printer system, known as the Morkum,

and which at the present time is quite extensively employed on both commercial and railroad telegraph lines.

In the year 1909 the American Telegraph and Telephone Company purchased a controlling interest in the Western Union Telegraph Company, with the object of effecting economies which it was thought would ensue from the complementary operation of the lines owned by each company.



Automatic Tape Transmitting Instruments in the Penzance, England, Atlantic Cable Office

The combination lasted until January, 1914, when it was dissolved on account of government objection to the continued joint operation of what were considered competing wire systems.

The introduction of "night-letter" and "day-letter" service in the year 1911, although quite an innovation in this country, very soon yielded an increase in wire traffic which seriously taxed the existing facilities of both the Postal and Western Union Companies.

The Western Union Company met the situation by developing to a high degree of efficiency a multiplex printing telegraph system based on the patents of Mr. Donald Murray, of London, England, while the Postal Company terminated all contracts for leased wires to brokerage concerns, thus releasing all of their wires for message traffic taken in over the counter.

In the year 1871 the number of telegrams handled daily in the main office of the Western Union Company at New York was 3,500. In 1875 this had grown to 35,000 telegrams per day. In the year 1917 approximately 200,000 telegrams daily are handled through this office, and it requires the space of three entire floors of the big telegraph building at 24 Walker Street to house the apparatus and staff necessary to handle this great volume of traffic. Seating space is provided for 1,025 telegraphers.

All of the regular "message" wires extending between New York and Chicago are operated by the printer system, as also are most of the principal direct circuits connecting New York with other large cities north, east, south and west.

The Postal Telegraph-Cable Company also is doing an enormous business throughout the United States. Direct

wires are maintained between New York and all cities of importance in this country and in Canada. The company's own cable system supplies rapid fire connections with Europe via the Atlantic, and with China and Japan via the Pacific ocean.

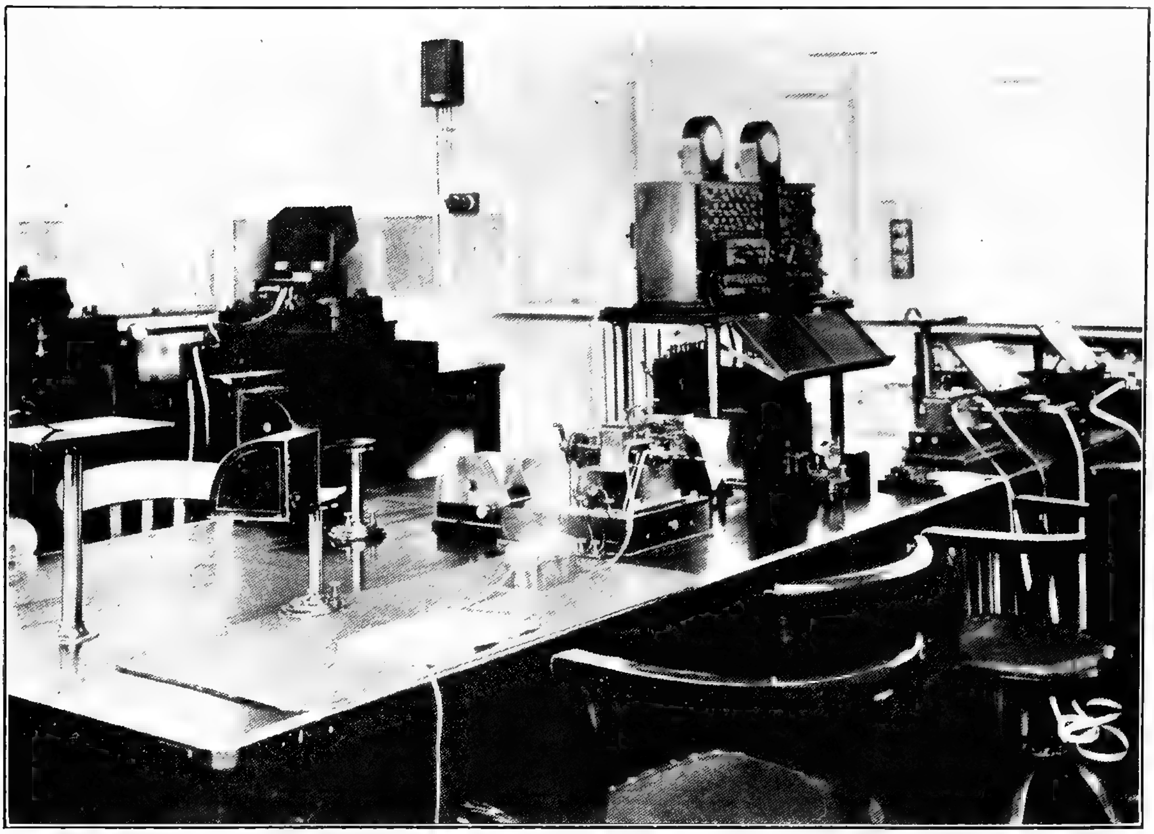
At the present time—twenty-five years after toll telephone service was inaugurated between New York City and Chicago—we find that there are about fifty thousand commercial telegraph employees in tne United States. This is exclusive of railroad telegraph employees to an almost equal number.

There are approximately 250,000 miles of telegraph pole line and 2,000,000 miles of telegraph wire, besides 320,000 miles of wire owned and operated by railroad companies in the United States.

As an illuminating commentary upon the importance to the nation of the telegraph and the telegrapher, it may be pointed out that a few months ago when the registration of the national resources was called for by the President, of the thousands of professions which men practice one of the very few considered in the registration was: "Are you a telegraph operator?"

Verily, as one writer has said: "The wire is serving. Seventy years ago a portrait painter sat at a clumsy desk in Washington and jiggled a metal tab with nervous finger. In Baltimore an armature clicked, and one understanding its untried speech translated the click into 'What hath God wrought!' That day was born the wire—born a creature of service; born to obliterate space and make the earth a back-yard for over-fence chattings between the peoples."

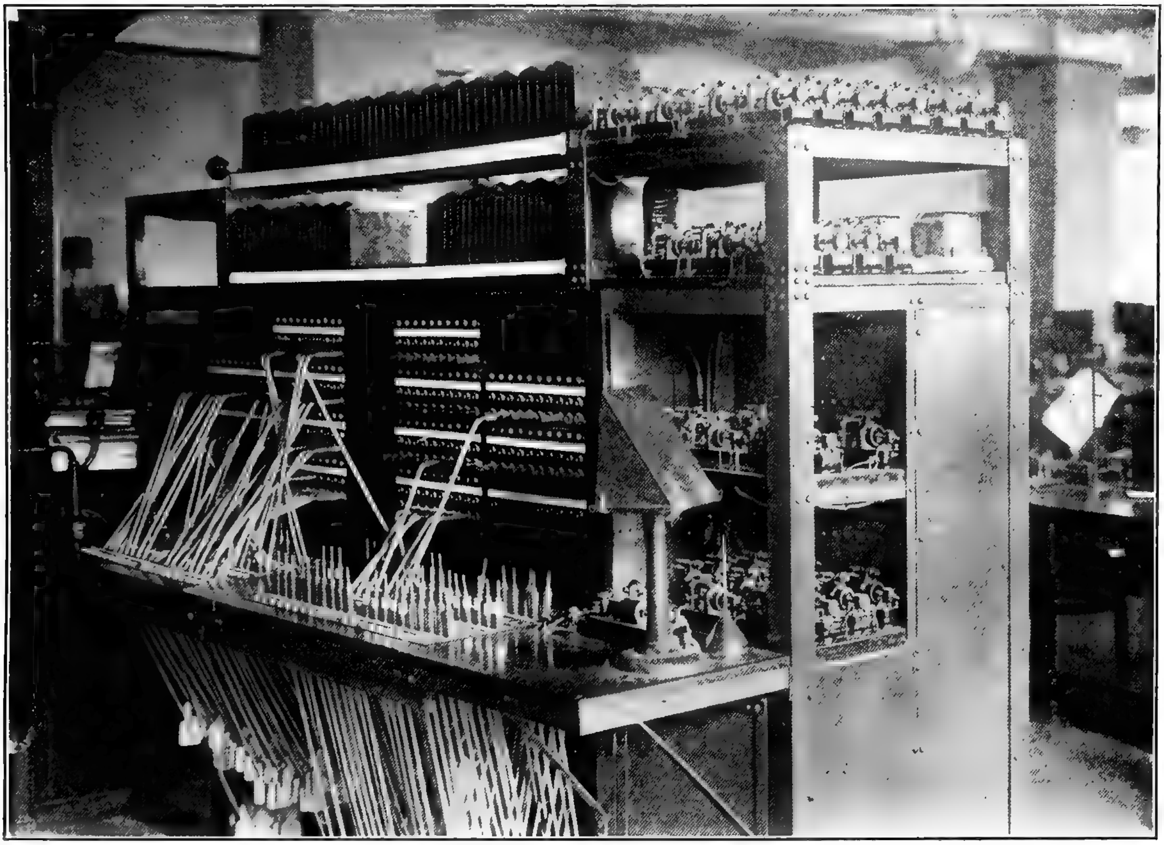
In the large American cities each telegraph company has one main operating room and from ten to two hundred branch offices scattered throughout the city. Former practice was to have all wires ex-



Interior View of a Corner in the Atlantic Cable Office at Penzance, England

tending from the main to branch offices connected to an individual set of Morse instruments at the main office. With this system unless an operator was maintained at each instrument at the main office calls were likely to go unheeded, resulting in serious delay to telegrams. About the year 1905 a system was introduced by J. T. Needham providing that all metropolitan short wires be connected through annunciator units, a large number of which could be mounted in front of and accessible to a monitor operator. The monitor observing the visual signal displayed when a branch office called, could in turn connect to the branch line, by means of a switching cord, any operator who at the moment was idle.

Later on (about 1912) improvements were made in this system. The photograph herewith reproduced shows this equipment as now used. The metropolitan telegraph lines, mostly under ground, are brought into a monitor switchboard resembling somewhat a modern telephone switchboard. Incoming telegraph calls are indicated by miniature red lamps lighting up, and remaining so until the call is answered. On the shelf level of this board is mounted a bank of miniature white lamps, each one being connected by wire to an operator's position somewhere in the main operating room. When an operator is idle the white lamp at the monitor board indicates this condition. The general result, therefore, is that at a given time all illuminated white lamps indicate idle operators and all illuminated red lights unanswered calls. The monitor operators job is to connect idle operators with incoming calls.



A Modern Monitor Switchboard in Metropolitan Telegraph Offices

This system equalizes the load, reduces delays, and constitutes one of the most noticeable differences between the telegraph of today and the telegraph of twenty years ago.

DONALD MCNICOL.

FIRE ALARM TELEGRAPH AND ELECTRIC POLICE PATROL SYSTEMS

The suggestion of the possibility of the use of the telegraph for fire alarm purposes came soon after the inauguration of the electro-magnetic telegraph by Morse, but the suggestion was not put to practical application for several years.

Dr. W. F. Channing, of Boston, is credited with having first suggested the idea in 1839, when the telegraph itself was still a crude and imperfect means of communication. Dr. Channing had no device or apparatus at that time, but in 1845, in a communication to the Boston Advertiser, he made a much more definite suggestion. He advised that "a central office should be established in some public building, in which the necessary battery, together with a Morse register and an alarm bell, should be located; a double wire to proceed thence over the housetops successively to every engine house and fire bell in the city and return again to complete its circuit to the place from which it started." Under this plan a Morse register in connection with an alarm bell was to be placed in each station thus established, also a key, by the simple depression of which an appropriate signal would be instantly conveyed to every station on the circuit.

Dr. Channing in this article also suggested the modification of having five or six circuits, or even a circuit from every station to the central office. By this method the operator would be able to communicate directly to all the stations, and, if so desired, every alarm of fire might be made to pass through the central office before being communicated to the different stations. Many other modifications of his design were suggested by Dr. Channing, one of which clearly indicates the electro-mechanical bell striker as follows:

> "There is, however, one which deserves to be specially mentioned. By a slight change of the arrangement of the alarm bell stations and increase of machinery, the hammers of the bells could all be disposed so as to strike mechanically on the communication of a galvanic impulse from the central office. The agent (operator) would therefore be enabled, by depressing a single key with his finger at certain intervals to ring out an alarm defining the position of the fire simultaneously on every church bell of the city."

After stating his ideas of the use of the telegraph for fire-alarm purposes, Dr. Channing urges the municipal authorities of Boston to give his project consideration, and says that as Boston had been much behind other cities in fire-alarm efficiency it would, by the adoption of this system, be placed in advance of them.

But nothing was done in the shape of electrical fire-alarm in Boston until the winter of 1847-1848. L. L. Sadler, superintendent of the Boston and New York telegraph line in a discussion with F. O. J. Smith about the feasibility of using telegraphy for fire alarm purposes, said that an operator in his employ at Framingham, Mass., named Moses G. Farmer, who was the most ingenious man he had ever seen, could without doubt work out a system that would operate effectively. Young Farmer, having the problem placed before him, took about a week to produce an apparatus, based upon electro-magnets and the striking mechanism of an old church clock. This was the first machine ever devised and constructed for giving a fire alarm by electric action, and was the starting point of all the subsequent work in that direction. But no early result came from it, though Mayor Quincy of Boston indorsed the apparatus.

Dr. W. F. Channing was still fully possessed with the fire-alarm idea, and in 1851 he succeeded in getting favorable action by the Boston City Council, which voted ten thousand dollars for experimentation in a fire alarm telegraph system. His plan, which was adopted with some modifications, provided for numerous box stations, connected by telegraph circuits with the central office, from which all alarm signals received from the boxes were to be sent out over other circuits to the bell towers, so that the box signals would be simultaneously struck, electrically, by every fire alarm in the city. The system as modified was adopted for thirty-nine signal stations and was carried out, making Boston the pioneer in the regular adoption of an electric fire-alarm system. Professor Farmer, who had invented the first fire-alarm electrical de-

vice, became superintendent of the Boston fire-alarm system, serving from 1851 to 1855, and was connected with the department in an advisory capacity until 1859. He and Dr. Channing became associated in the perfecting of the system, and by these two, singly and together, most of the basic patents of the present fire-alarm system were taken out.

Though the Boston system was the first to take permanent root and satisfactory form, it was not the first to use the telegraph as a signal of the existence of fires. The first municipal action taken by any city in connection with the use of telegraphy by a fire department was taken by the common council of the City of New York in November, 1846, when it authorized the adoption of the Morse magnetic telegraph into the fire service. At a meeting of the engineers and firemen, held a month later, some plans recommended by the chief engineer were approved, and a committee of five was appointed to secure their official adoption. In 1847 a permit was granted to Hugh Downing and Royal E. House, a prominent telegraph inventor, to set up a line of telegraph for fire purposes in various sections of the city, at a cost of five hundred dollars. In 1851 the connection of the bell towers with fire headquarters by telegraph was completed with beneficial results, but the official record shows that it aroused such public curiosity that the entire telegraph apparatus was often put out of service by the tampering fingers of innocent (but ignorant) visitors. So that nothing permanent resulted, and New York continued the old method with watchmen and bell towers until 1869, four years after the paid fire department had been organized, when the city took up modern electrical fire alarm methods. Outside of the official pioneer efforts, Charles Robertson (who introduced the Morse telegraph system into Germany), had utilized it in New York City in 1850 to aid the fire department in signalling the existence of fires.

The fundamental patent covering the invention of the fire-alarm telegraph, as exemplified by the Boston system, was granted to Dr. W. F. Channing and Moses G. Farmer May 19, 1857, and another patent was issued to them March 8, 1859, for a repeater.

To Farmer alone were issued May 4, 1852, patents for an improved signal box in which the magnets were shunted by the closing of the outside box door, a practice that became a permanent feature of fire alarm telegraph mechanism, and on February 22, 1859, he received a patent for an automatic system in which the central office is dispensed with, and the signal boxes and alarm bells are all placed in one circuit; and where, consequently, when an alarm of fire is given, all the bells will strike instantly and simultaneously, without the aid of an operator. This was called the "village system," because especially adapted to small places where the expense of a central office would be prohibitory. Two other patents were issued to Farmer in 1859—one for an "electric-magnetic apparatus for setting water motors in motion," which was applied, for a short time, to operate some of the bell-striking machines of the Boston system in place of weights. The other patent was for "mechanism for operating signal whistles by electro-magnetism."

In 1856 Charles T. Chester received a patent for "an automatic electric circuit breaker." It included a brake, moved automatically by means of clockwork actuated by a spring. This is notable as the first automatic signal box, and though this identical apparatus never came into public use, it was the forerunner of other devices that were of much value in fire alarm telegraph development.

The late John N. Gamewell, of South Carolina, came into the fire alarm telegraph situation in 1855 through hearing Dr. W. F. Channing deliver a lecture on the subject at the Smithsonian Institution in Washington. Mr. Gamewell was very much impressed by this exposition of the idea and workings of the system, and he at once entered into negotiations with Messrs. Channing and Farmer, and secured the right to use their inventions and patents in the Southern States. In 1859 he purchased the rights for the rest of the country. From his first connection with the fire alarm system he devoted his commanding business ability to the advancement and extended use of the fire alarm telegraph system. The original Boston system, installed in 1852, comprised only 19 tower bell strikers and 26 signal stations, and during the year 1854—two years after the system had been introduced—the number of fire alarms in

Boston was only 195. The Boston system, with some improvements, was taken up in Philadelphia in 1855, and St. Louis closed a contract in 1856, though the plant there was not in use until early in 1858. The cities of New Orleans and Baltimore adopted the system in 1860, but further development was seriously arrested by the outbreak of the Civil War. After the close of the war Mr. Gamewell organized the Gamewell Fire Alarm Telegraph Company, and devoted much vigor to the extension of the system.

When Mr. Gamewell purchased the Channing-Farmer patents he enlisted the co-operation of men of noteworthy inventive genius and great mechanical skill. Three of these were Edwin Rogers, James M. Gardiner and Moses G. Crane, who, by their inventions, made marked impress upon the progress of the fire alarm telegraph.

Edwin Rogers was the inventor who devised the new features of the first fire alarm system equipped with automatic signal boxes, which was introduced into the city of Mobile in 1866. It differed from Farmer's village system, which placed all the apparatus in one circuit, by providing four circuits, which was a novel feature, and for which Mr. Rogers invented a new apparatus which automatically transferred a signal from any one circuit to every other circuit, and would mechanically close every other circuit should any one circuit remain open. Mr. Rogers received a patent for the first automatic repeater for fire alarm purposes in 1870.

At Boston the original crank-operated signal boxes of 1852 remained until 1866, when they were replaced by automatic boxes. Joseph B. Stearns, who succeeded Farmer as superintendent of the Boston fire-alarm telegraph, received a patent for an apparatus operated by "reverse currents," which permitted the simultaneous use of the same wire for receiving a signal from a box and transmitting it to the alarm bells. For the proper working of this system it was necessary that the person turning in the alarm should, as the directions read, "pull the hook down once and let go." Where this was done the proper box number appeared at the central station indicator. But quite often the numbers turned in were unintelligible or erroneous, and this was long a mystery to the management. But it was finally discovered that the person signalling would frequently ignore the letter of the directions and would give one or more extra pulls by way of emphasis, and thus cause the trouble. Two patents to remedy this condition were issued: one to Stephen and Charles T. Chester, and the other to Edwin Rogers and Moses T. Crane.

Other interferences came from simultaneous alarms from several boxes on the same circuit. The first patent for a non-interference box was issued to Mr. Gamewell in 1871, and an improvement greatly enhancing its efficiency was patented by J. M. Gardiner in 1880. All of the devices were improved from time to time as working defects called for remedies.

In the early installations the Grove cell was used to furnish the electric energy, but it was succeeded by the much more satisfactory Daniell cell, which was used until the Callaud or gravity cell was introduced in 1871, and soon supplanted all previously used types of cells.

Since then the storage battery has taken the place of the gravity cells, and in the larger plants the dynamo has been applied to the purpose. The first to be thus equipped was Boston, about 1892, first for a single circuit, but soon after for the entire plant.

Even in its earliest applications the fire alarm telegraph possessed such manifest advantages over the old tower and watchman system that it would seem natural that its adoption should follow rapidly upon its first experimental demonstrations. But even after the Civil War conservatism and the devious ways of municipal politics retarded its adoption. The strongest opposition came from the volunteer fire departments which, in the larger cities, were made up of groups of local organizations that were in fact political clubs, each headed or controlled by a local boss. As the fire alarm telegraph, to reach a high degree of usefulness, needed behind it a paid fire department, strongly organized and co-ordinated upon a basis of complete efficiency, machine politicians saw in its adoption a blow at the volunteer companies which were such a strong factor in party strength. Therefore the system was not adopted until 1869 in New York, though it had been in

successful operation for seventeen years before that date in Boston. Most of the other cities lagged behind, for even in 1871 only twenty cities had adopted the fire alarm telegraph.

After that date, however, the system spread with great rapidity, and there were seventy-five cities using it in 1875. Following that year was a steadily expanding appreciation of things electrical, including the fire alarm telegraph, so that at the beginning of the Twentieth Century there was scarcely a city of ten thousand or more inhabitants that had not installed the fire alarm telegraph as a prominent feature of its fire protection programme, and many of even smaller population had adopted it also.

An improvement in signal boxes was introduced by Mr. Tooker, of Chicago, in 1875. Before that, delays had been frequent in transmitting alarms because the key to open the box could not be found on the instant. The Tooker keyless door was intended to deter malicious persons from sending in false alarms or otherwise interfering with the apparatus. The door was opened by the turning of a handle, which wound up a spring, thus setting in motion the mechanism by which a local alarm was sounded on a small gong within a box. The person using the Tooker device, having turned the handle of the door and heard the local alarm, often thought he had done all that was necessary, and would walk away without pulling the hook that sent in the signal to "central," so that the vital part of the signal was omitted. The next step in the development of the idea was the invention made by M. H. Suren in 1895. In the operation of this invention it was only necessary that the handle of the door should be turned, whereupon the bell rang and the alarm was transmitted to the central office without even opening the door of the box. A similar development is seen in the device patented by J. J. Ruddick in 1889, by means of which the boxes, besides being non-interfering, are made to succeed each other, each in turn sending in its own definite signal, even if three or four boxes on the same circuit are pulled at the same time.

Mention has been made of Edwin Rogers' automatic repeater, invented in 1870 as an improvement on Farmer's village system, which made it practicable to strike all the bells and gongs of a fire alarm system directly from one street signal box without the intervention of an operator at the central office. John P. Barrett, then superintendent of the fire alarm telegraph of the City of Chicago, invented in 1876 a device known as the joker which carried the valuable idea of the Farmer system into a new application and gave its benefits to large central station systems. By means of the Barrett invention alarms can be sent directly from a signal box to the fire companies whose duty it is to respond first, and this, in combination with the automatic repeater, was found to be an improvement of very great value in city fire alarm work.

In central stations of the fire alarm telegraph there have been many improvements to make the system more and more efficient. The electro-mechanical indicator, which was first introduced in 1875, is a general feature of the fire engine house, and as electrical art has progressed new and ingenious devices have been introduced to render more responsive and to speed up the operations of the fire fighting force.

There has been a continuous development of the use of the telephone for fire alarm purposes. Its efficiency for that purpose is very great in reporting fires in the business district or in the better residence sections, where the telephone is in general use, but in the poorer tenement sections, where telephones are few and inaccessible, the automatic fire alarm box, usually easily distinguished by the poles and boxes being painted red, is the main fire alarm resource.

Like other matters of electrical application, the fire alarm telegraph has been subject to constant innovation and improvement. New conditions of service have called for these advances, and while the system in use in the fire-protected cities of the United States are greatly varied, some cities finding the old equipment sufficient for their needs, others have found new methods necessary. In New York City, and especially in the Borough of Manhattan, where the main streets are underlaid by the wires of many circuits of various voltages, some of high tension, which were detrimental to the proper working of the fire alarm telegraph lines in the old fire de-

partment subway, it was found necessary to install a new modern fire alarm system for the island of Manhattan.

The matter had been long contemplated and in 1907 the need in this direction was investigated by J. J. Carty and Kempster B. Miller, who reported a preliminary plan and stated the engineering principles which should govern the new installation. The matter did not reach definite action until 1915, when a report was made to the Board of Estimate and Apportionment by Robert Adamson, fire commissioner, and Putnam A. Bates, electrical engineer.

Under the new plan the fire department discontinued the use for fire alarm purposes of the old fire department subways and also the high-tension subways of the Consolidated Electrical Telegraph and Subway Company, confining the fire alarm cables to the low-tension system of subways to be supplied by the Empire City Subway Company, thereby eliminating, as far as existing conditions make it practicable to do so, the possibility of contact between conductors of the fire alarm system and foreign circuits containing dangerous voltages. This project utilized such parts of recent construction as were adapted to the new system, and supplied the remainder by new construction.

Thus was introduced into the Borough of Manhattan an entirely new fire alarm system, modern in every respect, including the cables, fire alarm boxes, and a new fireproof central station in Central Park.

Under this plan only ten street boxes are attached to any single circuit. Each fire house is connected with the central office by circuits wholly independent of the alarm-box circuits, a maximum of four companies being connected on any one of these circuits. Fire alarms are sent to the new central headquarters from the street boxes, and are thence transmitted to the fire house over the central office circuit. Provision is made by means of independent circuits for notifying independently the chief of the department, his under chiefs, all fire-boat stations and the Insurance Patrol, so that they shall receive all alarms of fire at all hours. In this latter system is included a connection with the high pressure pumping stations, the Edison Company's waterside power station, which furnishes the current for the pressure pumping, and police headquarters. Wires in the feeder cables provide direct connections with fire headquarters in the Bronx, Brooklyn and Queens. Public schools, hospitals and other similar buildings are also connected with the street-box system, each such building having one box assigned to it.

Auxiliary systems of fire alarm telegraph, installed in convenient places in buildings, are important as fire-prevention aids. Boxes are placed in schools, for instance, near the teachers' desks. The box has a pane of glass in front which, in case of fire, is broken and a ring inside pulled down. This action operates a trip in the nearest street box and causes an alarm to be sent to fire headquarters. Such an auxiliary circuit has a special battery and is not connected electrically with the regular circuits of the fire alarm system.

Still another class of fire alarm telegraph apparatus is that known as the thermostatic group. In this the materials or mechanism of the thermostats are so sensitive to high temperatures that when a certain degree of heat is reached the circuit is closed and an alarm is automatically turned in. There are many applications of this principle, but one of the most widely known and most popular, particularly in textile factory districts where it has become a feature of insurance economy through "factory mutual" insurance organizations, is the combination of the automatic sprinkler with the thermostatic alarm. The same idea has also been applied to many stores and warehouses in the cities.

In connection with the efficiency of automatic fire alarms, the National Fire Protective Association has gathered some valuable statistics which give insight into the progressive efficiency of fire alarm service for the fifteen years from 1897 to 1911 inclusive. It was shown that where the protection was by watchmen alone there were failures in 10 per cent of the cases; by sprinkler alarm alone, 7 per cent of failures, and thermostats alone 21 per cent of failures. But in the later years of that period the thermostats made great improvement in efficiency, and in the year 1911 proved 100 per cent efficient. This increase of efficiency for thermostats, as compared with their earlier records, is because prior to 1905 very few automatic alarm systems were connected with central

stations except in a few cities. Most installations were without either connection or supervision by an operating company, hence both maintenance and service were often deficient. Only systems operating through a central station are now approved by the National Board of Fire Underwriters. Variations in interior fire alarm apparatus have to be sometimes made to adapt them to the legislation of particular states, and thus there is a special form of such apparatus to operate on the 110-volt direct-current underground circuits in New York City.

Installations of automatic fire alarm systems are now largely confined to city buildings, where the system is connected with a central station—operated by an alarm company—which, in turn, transmits the alarm to the Fire Department. The installation of thermostats in outlying or country risks has not generally proved satisfactory, owing principally to poor inspection and maintenance, rather than defects in mechanism.

The automatic systems which, installed and operated under present underwriters' rules, afford the most complete protection are those which combine the automatic thermostatic alarm with the automatic sprinkler system, thus extinguishing or at least retarding the progress of the fire, while giving effective alarm to bring assistance from the fire department.

In the various applications of electricity to the work of fire alarm the world's most useful servant, Electricity, has brought great and increasing efficiency and has saved vast numbers of lives and untold millions of dollars' worth of property.

ELECTRIC POLICE PATROL SYSTEMS

When the telegraph was introduced into use and had demonstrated its practicability, those charged with the administration of law connected with the detection and suppression of crime saw at once that it had great possibilities as a police aid. In fact, one of the earliest instances of the use of the telegraph in England—and that which did most to direct public attention to it at that time—was the forwarding from one city to another of a telegram describing an escaped murderer, who was promptly arrested by means of the assistance thus given.

American cities soon adopted the practice of enlisting telegraph operators as members of the police force, to transmit messages and receive signals over wires connected with the police stations in the various precincts. The usefulness of the telegraph was restricted by the fact that signals were based upon Morse Telegraphy with the use of the key and sounder, as that would require a large and expensive staff of operators. In 1858 a dial telegraph was made by the firm of Charles T. and J. N. Chester for the New York City Police Department, and the same device was soon afterward adopted by the City of Philadelphia. This system substituted for the Morse key and sounder an electrical apparatus, with a keyboard something like that of the typewriter, and enabled a message to be sent directly in letters of the alphabet, thus avoiding the necessity of translating them into dots and dashes and then having them translated back again. But even this work required a certain degree of technical efficiency in manipulation that few acquired, and except certain communications that could be made by a few short signals. Thus the telegraph, while in many ways a great help to the police, had severe limitations on its usefulness.

The invention of the telephone, therefore was a great boon to police administration, and in 1880 John P. Barrett, whose previous position as superintendent of the fire alarm telegraph of Chicago had been enlarged to that of superintendent of the city electrical department, introduced the combination of telegraph and telephone as an auxiliary to the police force. In the exhaustive census report on "Electrical Industries, 1902," edited by Thomas Comerford Martin and published by the Government Census Bureau in 1906, the early history of this combined system is briefly epitomized, as follows:

"The system was first installed in one of the most turbulent districts of the city, and at once increased tremendously the efficiency of the force, chiefly in the way of

making a rapid concentration at any troubled point. Its success was so rapid that by 1893 no fewer than one thousand street stations had been installed all over Chicago, and in addition several hundred private boxes had been put in, giving instant communication, at any hour of the day or night, with all the stations of every precinct. Since that time the idea has been carried even farther in various ways, not only in Chicago, but in other cities. Milwaukee was the second city to adopt the police telephone booth, the installation being made in 1883. Brooklyn followed in February, 1884, with many improvements, which appear to have been made there for the first time. Upon the suggestion of Frank C. Mason, superintendent of the police telephone bureau, iron boxes, similar to those employed in fire alarm telegraphy, were used instead of the unsightly booth. Philadelphia, however, adhered to the booth, introducing it in July, 1884. Since that time the system has been extended year by year, and some of the more modern street boxes have been introduced.

"As the work in Chicago is typical, and is the fundamental form from which the others have been evolved, a brief description of it may be given. A special feature was the adoption, for street stations, of an octagonal booth or inclosure about 8 feet high and 2 feet 4 inches in diameter. For many reasons such sentry boxes are preferable to boxes on walls or lamp-posts, as the patrolman, once within, is secure from interruption while communicating with headquarters, and, moreover, the intelligence he wishes to convey can be kept secret—a matter of considerable importance on many occasions. Keys which will open any of the street stations and boxes are given to the patrolmen of the district, and are also placed in the hands of responsible citizens, the names of the citizens and the number of the keys being carefully recorded. The citizen's key only turns in a call for help, but the patrolman's key gives him access to the inner box, from which he can transmit calls, signals, and reports, by means of telephone receivers and transmitters, and other apparatus.

"The private boxes placed in residences, banks, hotels, etc., enable the persons using them to call up the police at any time by simply turning in an alarm, by pulling the lever or handle attached to the box, so that upon arrival the police can immediately let themselves in and proceed to business. Each night the renter of the alarm box can make a test of the system, an answering ring showing the line to be in working order; in the same way, after an alarm has been sent in, a return tap signal of the bell gives assurance that the call has been heard and will be attended to immediately."

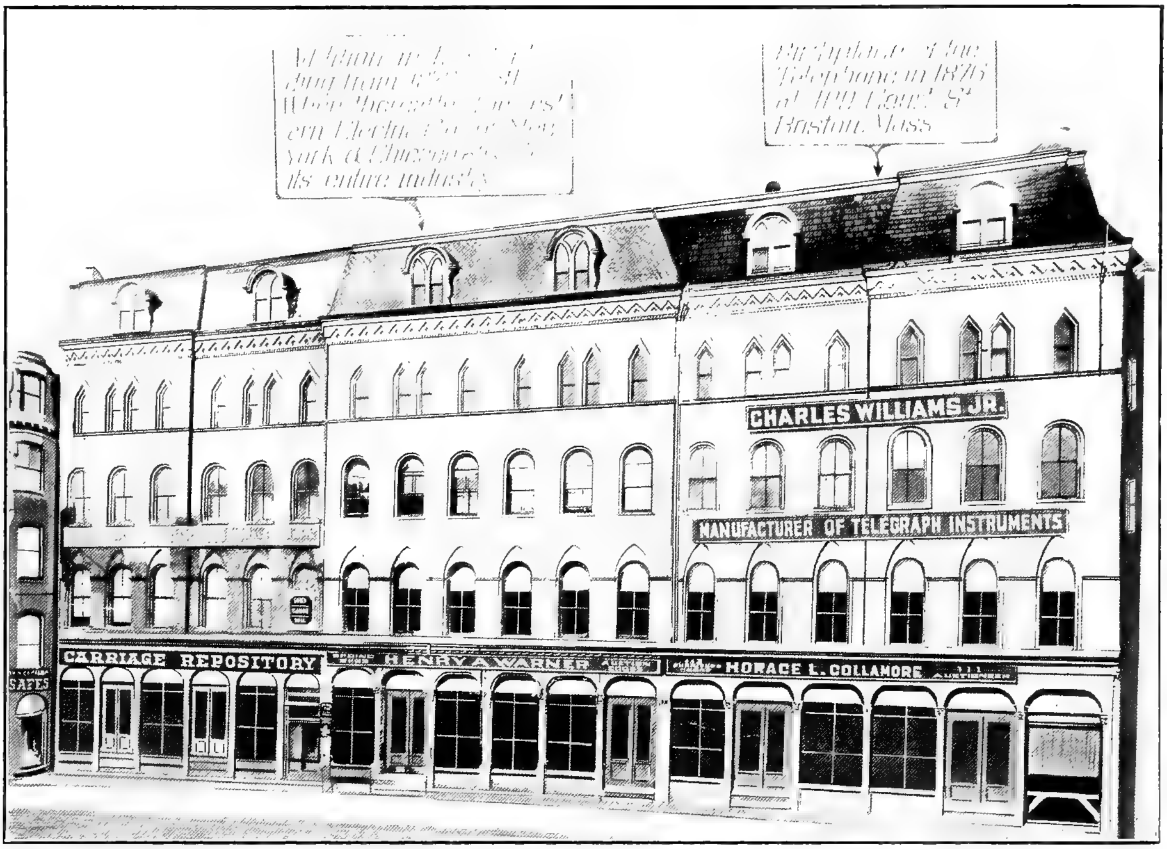
The introduction of the telephone as a major feature of the police patrol systems, did not do away with other signalling features. The importance of being able to converse by telephone is very great, but automatic signalling, where applicable, is safer because it is not liable to the misunderstanding which often comes when an excited dispatcher and a confused operator are at the opposite ends of the wire.

In connection with this police patrol system visual signals were introduced, including semaphores by day and flashlights by night, using either the ordinary lamp-posts or lamps placed on top of the booths; and the ringing of a large bell was an additional feature. Not only are the visual signals used for registering the proper circulation of patrolmen on their beats, but they have the further advantage that they can be operated on all the boxes on any one circuit.

Police patrol systems continue many features of this original system, the signal box being provided with a telephone, by means of which patrolmen can communicate with police headquarters. But various other devices for signalling and telegraph purposes have been invented and are in use in various cities. Through one type of box the patrolman advises the central office of his being on duty by opening the box with a special key, thus transmitting the number of the box, which, with the time, is recorded automatically upon a slip of paper by an electric time stamp. These signals are transmitted at a higher rate than fire alarm signals, for the reason that no heavy apparatus, such as a gong, is used. They work upon a principle similar to that of a watchman's automatic registering system, being received at the central office without the intervention of an operator. The mechanism of the box is such that when a signal requiring immediate atten-

tion is sent in, a local circuit is closed by a bell magnet, thus calling special attention to the incoming signal, and various other modifications are made to suit the various conditions and emergencies.

Of a late type are the seven call boxes recently installed for the police signal system of the city of Winnepeg, Man. There are two distinct circuits brought to each box—one a telephone circuit and the other the signal or telegraph circuit. The telephone instrument is an ordinary common battery-bridging set, the transmitter being mounted on the inner door. Included in the signal circuit and within the box is an electro-mechanical mechanism actuated either by turning a key in a special keyhole in the outer door, or (after opening the outer door) by pulling a lever. Either operation automatically transmits a number of impulses, giving the number of the box and the patrol wagon signal. As this is the most urgent signal, no other act is necessary to secure this aid. There is also a movable pointer, normally set at wagon position, and automatically returning to that position, after having been used at any other position. By its means it is possible to transmit automatically a fire or ambulance call, or the patrolman's report signals, three of which are separately designated. There is also wired into this circuit, but not exposed to the patrolman, a single stroke bell enabling the officer to know whether the line is already in use; a telegraph key for inspector's trouble signals, and automatic cut-outs that operate upon the closing of the outer door. The mechanism is very accurate and speedy, and represents the great advance made in such signalling service as the result of modern invention.



109 Court Street, Boston. *Courtesy of A. Arthur Ziegler.*

THE BIRTHPLACE OF THE TELEPHONE IN 1876

The machine shop of Charles Williams, Jr., as shown above was the headquarters of Professor Alexander Graham Bell and his faithful assistants during the months of experimentation with telephonic apparatus. And from this modest building, now reconstructed as shown on another page, into a moving picture theatre, but forever famed, emanated the invention which to this date has probably done more to expedite the world's affairs than any other invention of the human brain

CHAPTER III

THE STORY OF TELEPHONY

The Beginning and Successful Completion of the System Which Has Made Possible the Modern Business World

Wireless and Long Distance Telephone

MOST epoch-marking inventions have been, and those in the future doubtless will be, the subject of protracted and often acrimonious litigation. This is due in some instances to the simultaneous discovery of the same principle by different inventors, for there is such a thing as "independent invention." In other cases, an invention is attacked in the courts as part of a policy of so-called business strategy, while in instances which are happily few, the raid on a discoverer's property partakes of the nature of blackmail. Edison is said to have described a patent as "an excuse for a fight."

The telephone was no exception. Before Bell's standing as the inventor of the commercial telephone was established immense sums of money were spent for legal talent, competent witnesses and the manufacture of models with which to demonstrate the principles involved. The fact was determined, however, beyond dispute that in 1876, at the time of Bell's invention of the speaking telephone, there was not in the hands of the public anywhere in the world a single operative telephone. The whole telephone art and industry dates from 1876-1877.

The fundamental basis of telephony probably may be attributed to Page, an American, who discovered in 1837 that an iron bar when magnetized and demagnetized at brief intervals of time gives forth a sound due to the molecular disturbance of the mass. Reis, a German, utilized this principle and built apparatus for the transmission of musical sounds to a distance by electrical means. Prior to this, however, the idea of telephony had been defined in a remarkably clear way by Joseph Bourseul, a young French soldier, in Algiers. He already had attracted the attention of his superiors by the mathematical instruction which he gave to his fellow soldiers in garrison. Under the title of "Electrical Telephony" the journal "L'Illustration de Paris," August 26, 1854, described Bourseul's idea as follows:

"No further machinery and knowledge except a galvanic pile (battery), two vibrating plates and a metallic wire needle. Without other preparation one would only have to talk against one of the metallic plates, and another would have to hold his ear against the other plate. In this way they could converse with each other."

In spite of this wonderfully lucid and brief statement of the telephonic principle, it seems to have been the beginning and the end of Bourseul's endeavors. So far as can be ascertained he never reduced his idea to practice and no one was ever found who had seen a telephone constructed by Bourseul. There is certainly none in existence today.

Reis, however, actually built apparatus which could be made to transmit sounds and, it was claimed, human speech. In his biographical notes, written in 1868, Professor Reis says:

"Incited thereto by my lessons in physics, in the year 1860 I attacked a work, begun much earlier, concerning the organs of hearing and soon had the joy of seeing my pains rewarded with success, since I succeeded in inventing an apparatus by which it is possible to make clear and evident the functions of organs of hearing, and with which, also, one can reproduce tones of all kinds at any desired distance by means of the galvanic current. I named the instrument *telephon*. The recognition of me on so many sides which has taken place in consequence of this invention, especially at the Naturalists' Association at Gnesen, has continually helped to quicken my ardor for study that I may show myself worthy of the luck that has befallen me."

During the period 1861-1864 Reis exhibited his apparatus a number of times and sent duplicates to various parts of the world. In 1865 Professor Clifton made a demonstration with the Reis telephones before the Manchester (England) Literary and Physical Societies. The year book of the Physical Society, of Frankfort, Germany, for 1860-61 contains a discussion by Reis in which he points out that every tone or combination of tones entering the human ear causes its membrane or eardrum to vibrate. The sense of sound is produced by the motion of these vibrations, and every change in the motion must necessarily be accompanied by a change in the sensation. Therefore it would be possible to transmit such sounds electrically, set up vibrations or curves like those of any given tone or combination of tones and receive the same impression as the tone itself would have produced.

Reis elaborated this idea into an apparatus built upon the principles of the human ear, to which the earliest forms had a rough but striking resemblance. His first device embodied a small cone covered at its lesser end with an animal membrane upon which a small platinum strip was fastened with sealing wax. The receiver consisted of a violin upon which a knitting needle, with a coil wound around it, was fastened. When the sound waves made the membrane vibrate the circuit was closed as they impinged, and the strip of platinum beat against a tip of metal, the degree of contact being altered with each vibration. The sound waves threw the electric current at the point of variable contact into pulsations of varying strength, and corresponding effects were produced at the receiving end.

Twelve ingenious forms of the Reis apparatus were worked out. All embodied the idea of the human ear, with its auditory tube, tympanum, etc. The first device used by Reis as a receiver consisted of a steel knitting needle wound with a spiral coil of silk-covered copper wire. When it was determined that the sounds produced by rapid magnetization and demagnetization could be improved by the addition of a sounding box the needle was mounted upon the sounding board of a violin. A cigar box also was tried. The final form of the knitting needle receiver adopted by Reis was essentially of this box type. The needle and its helix lay on a rectangular box of thin pine wood and the coil of wire was mounted upon a light wooden bobbin instead of being twisted around the needle itself. Two wooden supports held the ends of the needle and over this was placed a hinged box lid. In the original apparatus this lid when closed pressed tightly upon the steel needle. Reis's own instructions were to press the lid firmly against the needle in order that the sound might be intensified, as was done unconsciously by the listener with his ear pressed against the lid in order to hear more distinctly. At one end of the sounding box was a small telegraph key used to interrupt the circuit and to telegraph signals back to the transmitting end of the line.

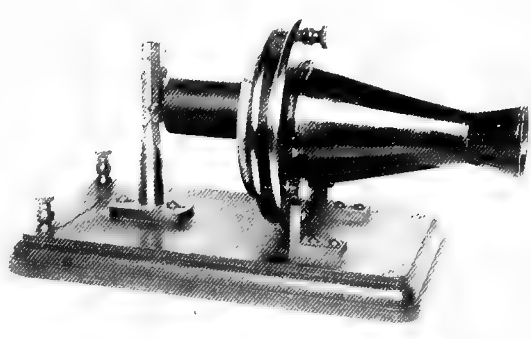
A great deal of testimony has been produced to prove that not only musical sounds but words and phrases were actually transmitted by this device, as they can be today in modern models of the apparatus. But since the invention rested upon the make-and-break principle, the electrical circuit having to be made and broken every time a sound impulse was transmitted, it was so extremely delicate that it was impossible to maintain it in adjustment for more than the shortest space of time. Reis himself said to Herr Garnier, to whom he disposed of his instrument and tools, that he had shown the world the way to a great invention which must be left to others to develop. Appreciation of the work of Reis has

been shown in this country and in Europe. In 1878 a monument was erected to his memory in Frankfort, the inscription on which styled him "the inventor of the telephone."

During the early litigation over the invention of the telephone, one of the American judges said that, however ingenious this pioneer work may have been, a hundred years of Reis would never have given to the world the telephonic art for public use as it exists today. Both before and after the invention of the Bell telephone many attempts were made to apply in practical apparatus the make-and-break principle of Reis, and some of the workers in this field devised transmitters approaching the modern microphone, now so essential. But, up to 1876, the telephone was utterly unknown to the public, and the scientific apparatus for laboratories and schools, formerly bearing the name, remains to this day virtually incapable of improvement that would bring it within the possibility of public utility. Suggestive and helpful as the work of Reis must have been to all who were familiar with it, the art of speaking telephony had to find its perfection and its future possibilities in some other direction than the make-and-break system with pulsatory currents.

United States Patent No. 174465 issued on March 7, 1876, to Alexander Graham Bell marks the beginning of one of the important epochs in the world's history. On it—"the most valuable single patent ever issued"—is founded one of the farthest-reaching and highest developed of man's industries. The unity of the nation fairly may be said to have been cemented by the invention and development of the Bell telephone.

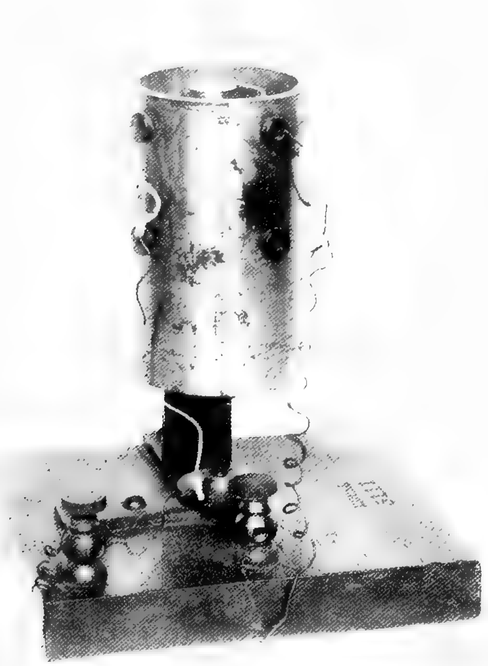
Bell's application for his original patent was filed on February 14, 1876, after a great deal of experiment and investigation. Bell, who, as a teacher and student of vocal physiology, had exceptional qualifications for determining feasible methods of speech transmission, constructed his first pair of magneto telephones in 1875. Each of these consisted of an electro-magnet, a U-shaped iron bar around one member of which a coil of wire was wound, while a thin iron plate or armature was hinged to the other member, extending also over the wire-surrounded core. A diaphragm of membrane, stretched across the tube, served as a mouthpiece, being mounted in a frame having its center immediately opposite the active pole of the magnet to which the iron armature was attached. All during 1875 Bell experimented with apparatus of this character, varying the proportion and arrangement of the coil, the magnets, the armature, etc. This was virtually the apparatus figured and described in the patent specifications, with the addition of hollow cones attached to the armature membranes in order to concentrate the voice at the transmitting end and to assist the ear at the receiving end.



Professor Bell's Single Pole Telephone as Shown at the Centennial Exposition

A paper read by Bell before the American Academy of Arts and Sciences at Boston on May 10, 1876, constitutes the first published account of the speaking telephone. In the summer of 1876 Bell's crude mechanism was exhibited at the Centennial Exhibition at Philadelphia and won the enthusiastic admiration of the world's leading physicists, as well as the plaudits of the people. During this same year Bell tried the substitution of a permanent magnet for the electro-magnet and toward the end of the year he usually employed the permanent magnet, omitting the battery. Practically the same results are obtainable with the electro-magnet and the permanent magnet over short distances, but early it was found that the magneto telephone had very definite limitations as to distance of operation and clearness of utterance. The great advance

that Bell now made was to devise a mechanism for both kinds of apparatus that would produce undulations of the electric current in the circuit corresponding to the sonorous vibrations of the voice, thus rendering practicable the continuous and intelligible transmission of human speech. The principle so discovered and embodied in practical apparatus was defined as follows in the specifications of the Bell patent:



Professor Bell's Iron Box Telephone as Shown at the Centennial Exposition

"Electrical undulations induced by the vibration of a battery can be represented graphically without error by the same sinusoidal curve which expresses the vibrations of the inducing battery itself and the effect of its vibration upon the air; for, as above stated, the rate of acceleration in the electrical current corresponds to the rate of vibration of the inducing body, that is, to the pressure of sounds produced. The intensity of the current varies with the amplitude of the vibrations, that is, with the loudness of the sound; and the polarity of the current corresponds to the direction of the vibrating battery, that is, to the condensation and rarefaction of the air produced by the vibration."

Claim 5 of the patent sums up this principle as follows:

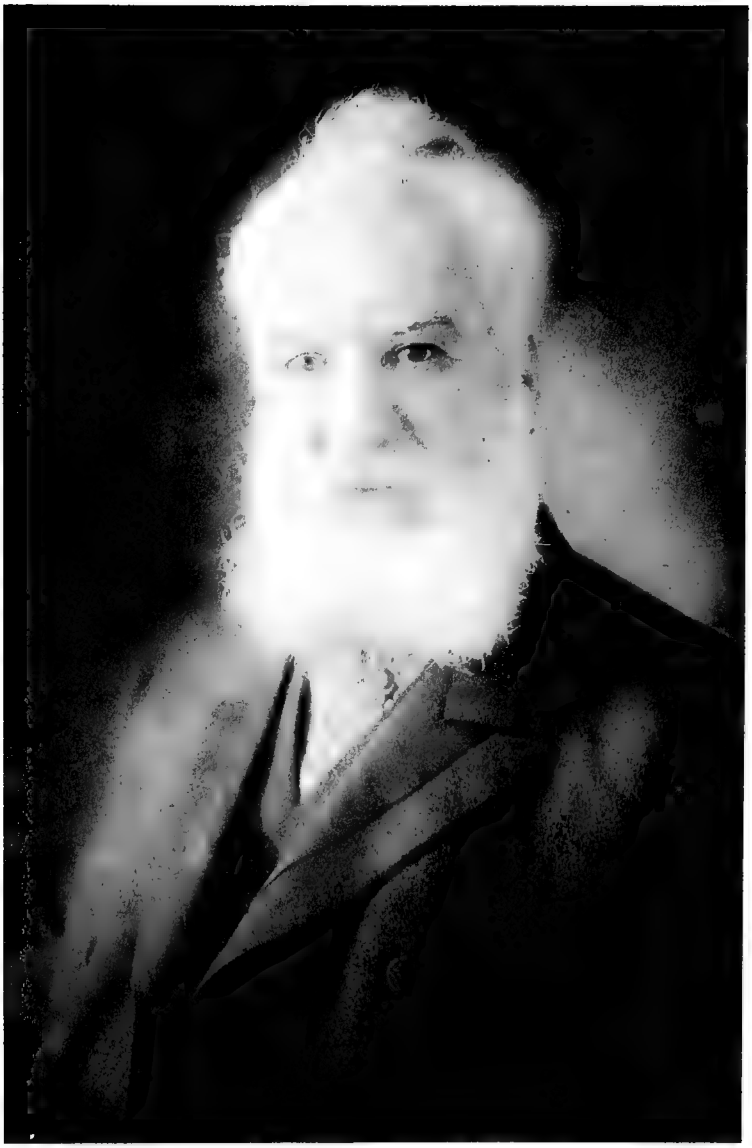
"The method of an apparatus for transmitting vocal air into sounds telegraphically, as herein described, by causing electrical undulations similar in form to the vibrations of the air accompanying the said vocal air into sound substitutes as set forth."

In his "The History of the Telephone" Herbert N. Casson gives the following account of one of Bell's early experiments:

"In that somewhat distant year 1875, when the telegraph and the Atlantic cable were the most wonderful things in the world, a tall young professor of elocution was desperately busy in a noisy machine-shop that stood in one of the narrow streets of Boston, not far from Scollay Square. It was a very hot afternoon in June, but the young professor had forgotten the heat and the grime of the workshop. He was wholly absorbed in the making of a nondescript machine, a sort of crude harmonica with a clock-spring reed, a magnet and a wire. It was a most absurd toy in appearance. It was unlike any other thing that had ever been made in any country. The young professor had been toiling over it for three years and it had constantly baffled him, until, on this hot afternoon in June, 1875, he heard an almost inaudible sound—a faint *twang*—come from the machine itself.

"For an instant he was stunned. He had been expecting just such a sound for several months, but it came so suddenly as to give him the sensation of surprise. His eyes blazed with delight, and he sprang in a passion of eagerness to an adjoining room in which stood a young mechanic who was assisting him.

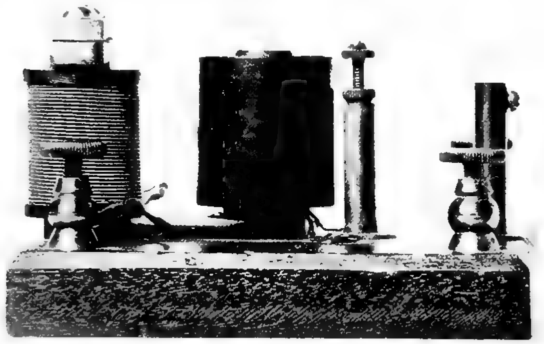
" 'Snap that reed again, Watson!' cried the apparently irrational young professor. There was one of the odd-looking machines in each room, so it appears, and the two were connected by an electric wire. Watson had snapped the reed on one of the machines and the professor had heard from the other machine exactly the same sound. It was no more than the gentle *twang* of a clock-spring; but it was the first time in the history of the world that a complete sound had been carried along a wire, reproduced perfectly at the



ALEXANDER GRAHAM BELL

other end, and heard by an expert in acoustics.

"That twang of the clock-spring was the first tiny cry of the new-born telephone, uttered in the clanging din of a machine-shop and happily heard by a man whose ear had been trained to recognize the strange voice of the little newcomer.



The Harmonic Machine of 1875

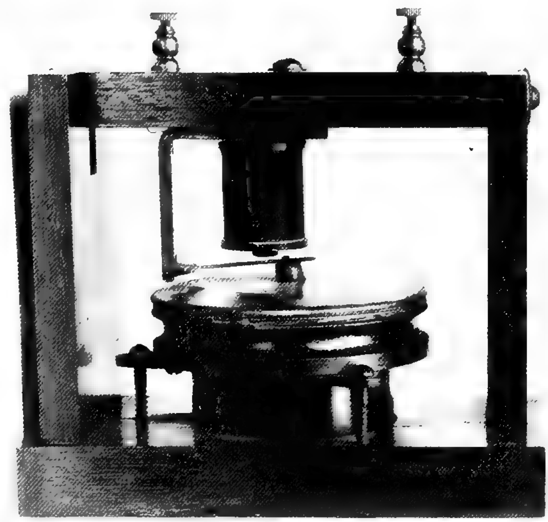
There, amidst flying belts and jarring wheels, the baby telephone was born, as feeble and helpless as any other baby, and 'with no language but a cry.'

"The professor-inventor who had thus rescued the tiny foundling of science was a young Scottish-American. His name, now known as widely as the telephone itself, was Alexander Graham Bell. He was a teacher of acoustics and a student of electricity, possibly the only man in his generation who was able to focus a knowledge of both subjects upon the problem of the telephone."

The historic conversation between Bell and his assistant, Thomas A. Watson, occurred on March 10, 1876, in the machine-shop referred to above. It was the first time the telephone transmitted connected sentences audibly and distinctly. In all the early experiments Watson, who had a peculiarly keen sense of hearing, did the listening while Bell, who was a professional elocutionist, did the talking. On this occasion Watson was in the basement of the shop listening when Bell said, "Mr. Watson, come here; I want you." Watson took the three flights of stairs on the jump and cried breathlessly to Bell: "I can hear you! I can hear the words!"

Rapid improvements were made in the apparatus shown at the Centennial Exhibition and the receiving part of the magneto telephone soon took the shape which has long been familiar. The iron plate armature and the connected diaphragm became one member and a single sheet iron diaphragm, or disk, such as is used today, was adopted. The coil of wire around the magnet was shortened until it became the flat bobbin, or spool, that is now a characteristic feature of the receivers, placed at the end of the magnet nearest the diaphragm. The speaking trumpet, or cone, of the resonating space was flattened until it became the shallow cup which enables one to rest the ear directly upon the telephone.

In August, 1876, Bell performed a lengthy series of experiments over a five-mile telegraph line in Canada. On the evening of October 9, 1876, the first long conversation ever carried on telephonically was held over a telegraph line extending from the office of the Walworth Manufacturing Company in Boston to their factory in Cambridge, Mass.



The Gallows-frame Telephone Apparatus

Every word of this conversation was recorded at both ends. In November, 1876, a telephone was used over 200 miles of circuit between Boston and Salem, Mass., by way of North Conway, N. H., and a little later a conversation was carried on by Bell between Boston

and New York over a Western Union telegraph circuit. The apparatus used in all these demonstrations was the magneto telephone as distinguished from the battery type.

About this time men with capital at their command began to notice the new invention, and it was deemed wise to invite the support of the public for this radical departure in methods of communication.

Bell's First Hand-telephone

A circular was issued which read as follows:

"The proprietors of the telephone, the invention of Alexander Graham Bell, for which patents have been issued by the United States and Great Britain, are now prepared to furnish telephones for the transmission of articulate speech through instruments not more than twenty miles apart. Conversation can easily be carried on after slight practice and with the occasional repetition of a word or sentence. On first listening to the telephone, although the sound is perfectly audible, the articulation seems to be indistinct; but after a few trials the ear becomes accustomed to the peculiar sound and finds little difficulty in understanding the words.

"The telephone should be set in a quiet place, where there is no noise which would interrupt ordinary conversation.

"The advantages of the telephone over the telegraph for local business are:

"1st. That no skilled operator is required, but direct communication may be had by speech without the intervention of a third person.

"2nd. That the communication is much more rapid, the average number of words transmitted in a minute by the Morse sounder being from fifteen to twenty, by telephone from one to two hundred.

"3rd. That no expense is required, either for its operation, maintenance or repair. It needs no battery and has no complicated machinery. It is unsurpassed for economy and simplicity.

"The terms for leasing two telephones for social purposes, connecting a dwelling house with any other building, will be $20 a year; for business purposes $40 a year, payable semi-annually in advance, with the cost of expressage from Boston, New York, Cincinnati, Chicago, St. Louis or San Francisco. The instruments will be kept in good working order by the lessors, free of expense, except for injuries resulting from great carelessness.

"Several telephones can be placed on the same line at an additional rental of $10 for each instrument, but the use of more than two on the same line where privacy is required is not advised. Any person within ordinary hearing distance can hear the voice calling through the telephone. If a louder call is required, one can be furnished for $5.

"Telegraph lines will be constructed by the proprietors if desired. The price will vary from $100 to $150 a mile; any good mechanic can construct a line. No. 9 wire costs 8½ cents a pound, 320 pounds to the mile; 34 insulators at 25 cents each; the price of poles and setting varies in every locality; stringing wire, $5 per mile; sundries, $10 per mile.

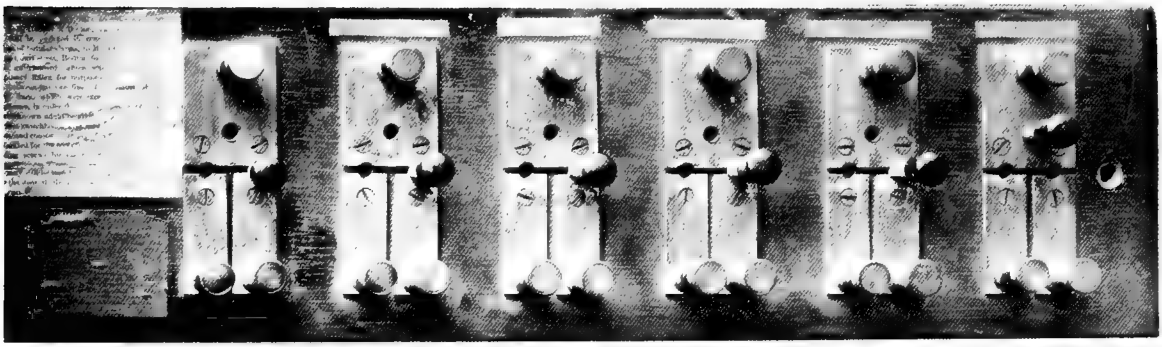
"Parties leasing the telephones incur no expense beyond the annual rental and the repair of the line wire. On the following pages are extracts from the press and other sources relating to the telephone.

"Cambridge, Mass., May, 1877."

Up to this time the telephone had not been developed beyond the connection of two stations by a single wire, but it had been from the start one of the ideas of Bell that there should be a central office having the function of making connection whenever desired between the lines of the several subscribers. Bell and his associates plainly set forth this idea in lectures given in Connecticut and New York in the spring of 1877. They outlined in a broad way both the central exchange system and long distance telephony.

The first line ever built especially for telephone service was put in operation on April 4, 1877, between the factory of Charles Williams, Jr., in Boston, and his home at Somerville, Mass. Shortly afterward a number of other lines of this character were erected. The majority of people, however, regarded the telephone as a toy, and its proprietors had great difficulty in enlisting the interest of investors.

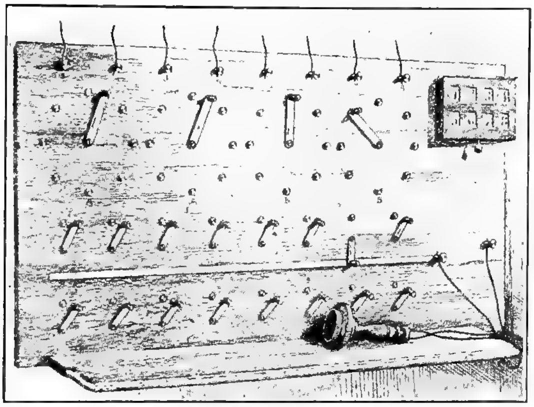
As soon as enough persons appreciated the utility of the invention, Bell and his associates recognized the need of an organization for dealing with the commercial features of their enterprise. Therefore, in 1877, an informal, unincorporated association, known as the Bell Telephone Association, was formed. It had no capital and few members. Its objects were to assist Gardiner G. Hubbard, to whom, as trustee, the Bell patents had been assigned, and to devise the best means for the general commercial introduction of telephones. Under the agreement Bell, Hubbard and Thomas Sanders had a three-tenths interest each in the patents and Watson one-tenth. At this time, August, 1877, Bell's patent was sixteen months old and there were in use 778 telephones. Of these four pioneer enthusiasts Sanders was the only one who had any money and his capital was limited. His business was cutting soles for shoe manufacturers and at no time was it worth more than $35,000. Yet he had furnished ninety per cent of all the money spent on the telephone from 1874 to 1878. Bell's room-rent, Watson's wages, the factory expenses and the cost of showing the telephone at the Centennial Exhibition all had been met by Sanders. His money built the first five thousand telephones, and before he had received any relief he had strained his credit almost to the limit and had signed notes aggregating $110,000. Later, when the Western Union Telegraph Company attacked Bell and his associates and thus greatly assisted in acquainting the public with the merits of the telephone, a number of Sanders' rich relatives came to his rescue and financed the earliest telephone enterprise, thus saving the situation for the pioneers and incidentally making great fortunes for themselves.



The Original Telephone Exchange Switch Board Designed and Used by E. T. Holmes, Boston, May, 1877

Meanwhile, it became necessary to develop some means of furnishing connection between the various telephone subscribers in one locality. In a crude manner the first exchange idea was carried into effect in May, 1877, in Boston, by making connection with the circuits of the Holmes Burglar Alarm Company. Four or five

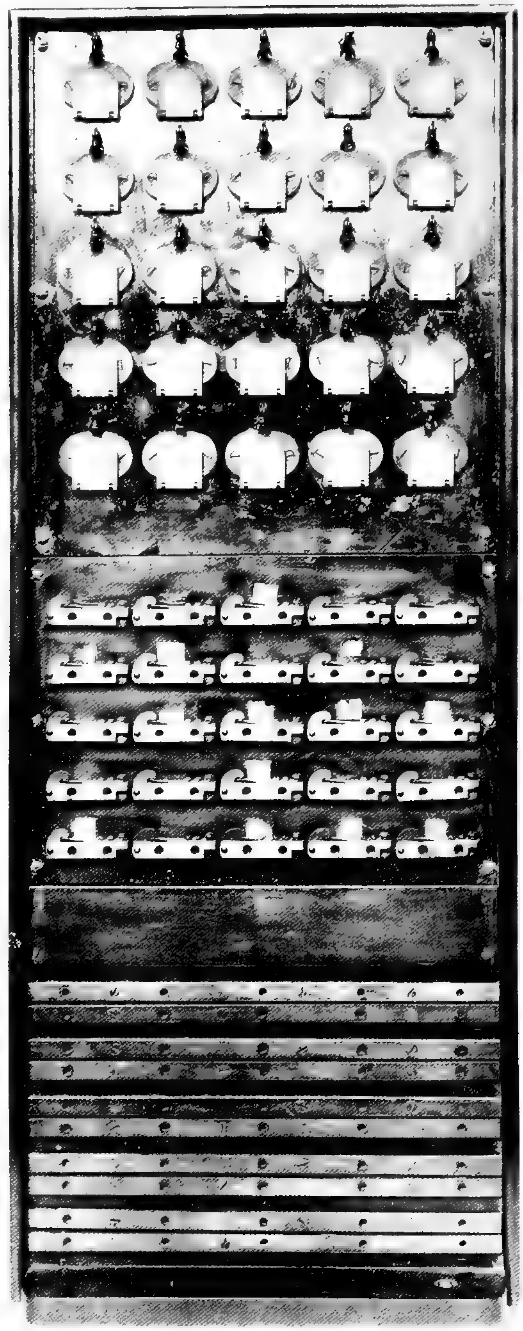
lines communicating with banks were brought to a small switchboard at the Holmes central office and the circuits were repeatedly interconnected at this board. Thus the Holmes system in Boston became a telephone exchange during the day and a protective burglar alarm system at night. As a matter of historical fact,



The First Telephone Switchboard Arranged for Eight Subscribers and Installed in the New Haven, Conn. Office in January, 1878

however, the first telephone central office system was that established at New Haven, Conn., and opened for business on January 25, 1878. This was the first fully equipped commercial telephone exchange ever established for general or public service. The skeptics who regarded the telephone as a scientific toy were largely converted by the building of central exchanges which enabled any subscriber to talk with any other. This was shown by the fact that three years later, or in March, 1881, there were in the United States only nine cities of more than 10,000 inhabitants and only one of more than 15,000 in which a telephone exchange had not been established.

The development of the exchange system seems to have been the turning point in the expansion of the telephone business, for the growth now went forward so rapidly that a more formal organization of the new industry became imperative. As a result the New England Telephone Company, with a capital of $200,000, was formed in February, 1878. This organization was given exclusive rights and license to use and to manufacture telephones in New England. In July, 1878,



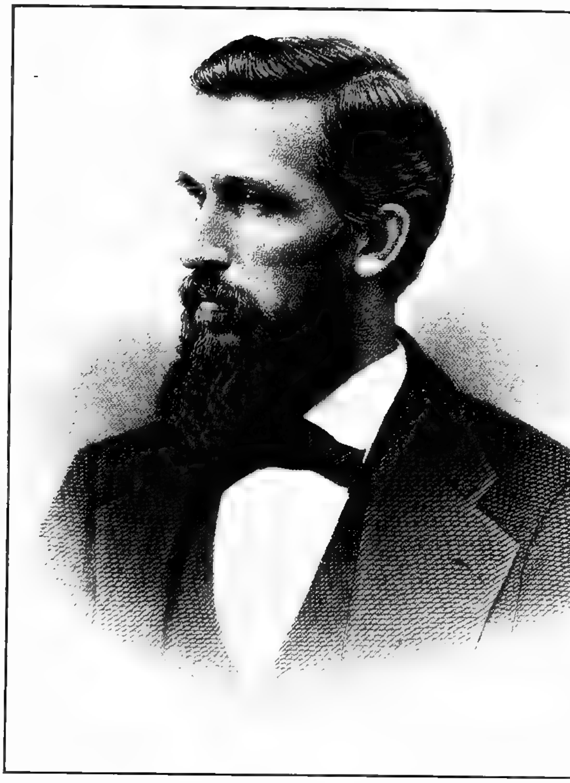
The Universal Switchboard Manufactured by the Western Electric Co. under Charles E. Scribner's Patent, and from which the Standard Switchboard Developed

the Bell Telephone Company was formed, with a capital of $450,000, and exclusive rights for the remainder of the United States. In March, 1879, these two companies were combined into the National

Bell Telephone Company, with a capital of $850,000. The commercial success of the business had by this time become assured, but it was found that the scope of the National Bell Telephone Company was not broad enough to meet the existing situation. Therefore the American Bell Telephone Company, with a capital of $10,000,000, was organized in March, 1880. This latter company, through subsidiary companies, displayed great ability in developing the telephone business of the United States on a territorial license basis and continued to operate until 1889. It was then absorbed by the American Telephone and Telegraph Company which originally had been created to handle the long distance telephone business of the American Bell Telephone Company.

It will be remembered that the original circular of the Bell Telephone Association specified the effective limit of speech as 20 miles. This limit did not long remain fixed. At the beginning of 1881 the work of telephonically connecting cities and towns had been commenced and was well under way. Boston could talk with 75 other communities, the lines reaching as far as Springfield, Mass. The success of the experimental long distance line between Boston and New York in 1884 convinced the public that conversations over distances of from 200 to 300 miles was commercially practicable. Owing to difficulties in securing terminal facilities it was 1887 before the longer lines were opened to public use. Extensions of these lines were carried on steadily. On October 18, 1902, the line between New York and Chicago was opened, while the Boston-Chicago line was put in service the following February. The maps of the long distance telephone lines as they existed in 1904 and as they are today show in a strikingly graphic manner the immense growth of the system and indicate the principal cause for the rapid rise in the use of the telephone. The whole of the United States is now a network of long distance telephone lines from Portland, Maine, to San Francisco and from the Mexican border to the Canadian boundary.

A share of the early commercial development of the telephone industry was due to the competition of the Western Union Telegraph Company with the Bell interests. In 1877 the Western Union saw in the telephone a dangerous rival to the telegraph and at once set to work to counteract the new influence. It began to develop a telephone system of its own based on the work of Edison, Elisha Gray, Dolbear and others whom it employed for the purpose. Elisha Gray had filed in the Patent



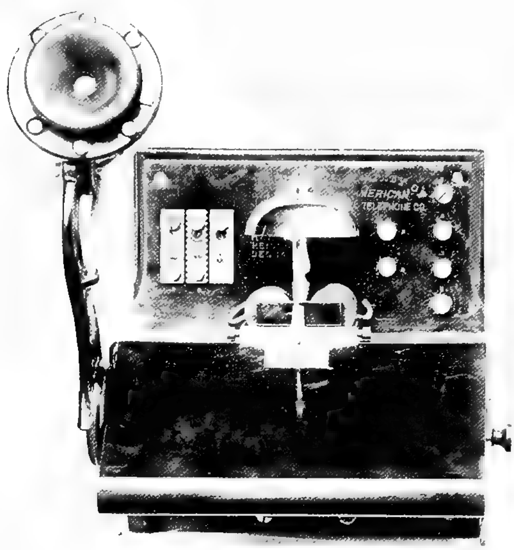
ELISHA GRAY

Professor Bell's early Competitor and Founder of the firm of Gray and Barton, now the Western Electric Company

Office at Washington a caveat for "a new art of transmitting vocal sounds telegraphically" on February 14, 1876, the very same day on which Bell had filed his application. This constitutes one of the most remarkable coincidences in the history of invention. But the Gray apparatus differed considerably, however, from that of Bell. The Gray caveat described a liquid transmitter so utilized that the vibrations of a plunger, or rod, attached to the membrane would cause variations in the resistance and consequently modify the current passing through the circuit to the receiver. In February, 1876, Gray made a pencil drawing illustrating this ingenious idea, but the liquid transmitters

brought out by Gray and others from time to time have never played any part in the development of the telephone art.

Edison, who was then in the service of the Western Union, succeeded in producing an excellent carbon transmitter. In this device the variations of resistance due to change of pressure in, or intimacy of contact between the particles of a mass of carbon effected the necessary variations in the electrical current carrying the impulse vibrations. This microphonic principle is a feature of all the successful speech-transmitting apparatus of the present day. Meanwhile, Emile Berliner and Francis Blake and Professor Hughes had developed efficient battery or carbon transmitters for the Bell interests. In fact to Emile Berliner is attributed the honor of having invented the first and original microphone transmitter in which two electrodes in constant contact were arranged to have the intimacy of such contact and consequently its resistance, and the current passing through it varied by the impact of the sound waves of the voice. Professor Hughes was also an original inventor of the same thing, although later; and it is to him we owe the term *Microphone*. Edison made an essential step in transmitter production when immediately after Berliner's work he determined for all time that carbon was the best material for the contact electrodes. The Western Union formed the American Speaking Telephone Company and pushed its telephone system vigorously throughout the country until it had a large number of exchanges in operation.



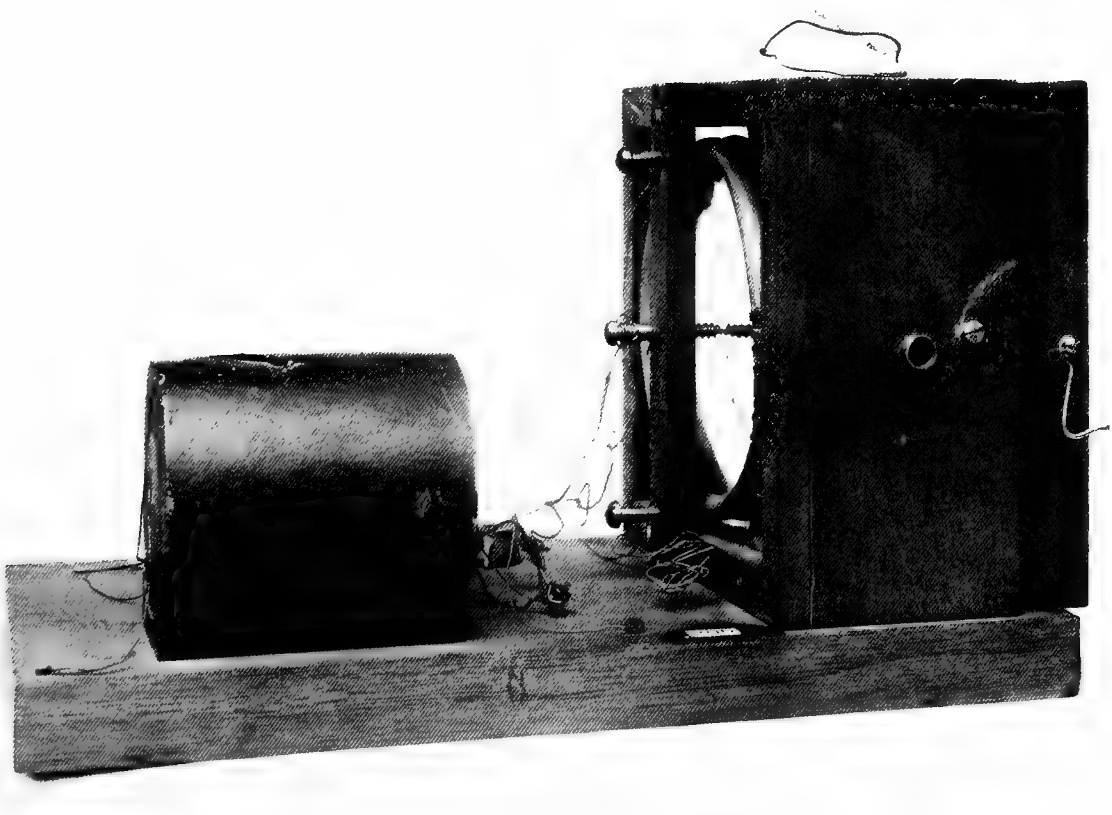
The Carbon Transmitter
Produced by Thomas A. Edison

In September, 1878, patent litigation between the rival companies was inaugurated. Then the Western Unon, conceding the priority of the Bell invention, proceeded to effect a famous agreement under which, by agreeing to pay 20 per cent of its income to the Western Union during the life of the contract, a period of seventeen years, the Bell Company obtained complete possession of the field and acquired all the telephonic inventions, apparatus and exchanges of the Western Union system. This combination not only unified the commercial systems of the whole country, but achieved the more important result of harmonizing and standardizing the apparatus and thus permitted easier and more rapid industrial and scientific development.

The Bell telephone was, at the very start, immediately introduced in Europe. There, as in the United States, the Bell patents throughout their entire term of existence, although frequently sustained wholly or in part, were subjected to constant legal attack and competition in every imaginable form. One of the results directly traceable to this cause is that the telephonic art has enjoyed the labor of many prominent inventors attracted by the opportunities and rewards offered in this field. The apparatus used at each end of the circuit as well as that at the central exchange, which at first was very crude, necessarily had to be developed commercially. The first switchboards used in central telephone exchanges were very similar in construction and operation to those used in telegraph offices. But these were very rapidly outgrown and replaced with devices especially created for telephone service. Many opportunities were thus afforded for the independent, and often competitive, inventor. Beginning with the one fundamental patent of Bell, already mentioned as "the most valuable single patent ever issued," the Bell interests gradually built up a

patent department which not only was charged with protecting the inventions of the Bell staff but which was constantly on the alert to acquire inventions which showed an advance in the telephonic art. It is said that at the present time the American Telephone and Telegraph Company is the owner of not far from 5,000 patents relating directly and indirectly to the telephone.

It was fortunate for Bell and his backers that they were enabled to secure the services of a remarkable triumvirate of men to defend their patent rights from the constant legal attacks to which they were subjected. The first of these was Chauncy Smith, a Boston lawyer of the Websterian type, whose resemblance to Benjamin Franklin was often remarked. In 1878, when he was called upon to defend the infant Bell interests against the attack of the powerful Western Union, he was known as the ablest patent lawyer in Boston. He was a big man physically and mentally. His team-mate, James J. Storrow, was physically small, with a quiet manner and a conversational habit of argument. He was known as "an encyclopaedia of definite information." It is related that when he first joined the Bell staff he spent an entire summer at his country home studying physics and electricity. The third member of this interesting triumvirate was Thomas D. Lockwood, who, in 1879, was appointed to organize a patent department for the young Bell company. Besides possessing a great deal of inventive ability, Lockwood was described as having "a memory like a filing system." These three men defended the Bell patents and held off the attackers while Theodore N. Vail, the General Manager of the company, was building up the infant telephone business from the commercial side. A writer on the telephone has described Storrow, in action, as a rapid-fire Gatling gun, while Smith was a hundred-ton cannon, and



The Patent Office Model of Emile Berliner's Original Telephone

Lockwood was the maker of the ammunition.

The three main arguments of the Bell attorneys, which were unanswerable to more than fifty eminent lawyers of the day, were: First, Bell's clear, frank story of "how he did it," which almost invariably embarrassed the pretender. Second, the fact that the most eminent electrical scientists of Europe and the United States had seen and examined the Bell telephone at the Centennial Exhibition and had pronounced it new. Third, the most significant fact that no one had attacked Bell's claim to be the original inventor of the telephone until his patent was seventeen months old.

The original Bell patent proved to be an invincible document. It went through an eleven years' war and emerged without a scar. It covered an entire art, and yet is was upheld and sustained throughout its seventeen years of life. The thirty-two words forming the last sentence of the Bell patent probably are the most valuable, from industrial and financial standpoints, ever penned. They read: "The method of, and apparatus for, transmitting vocal or other sounds telegraphically, by causing electrical undulations, similar in form to the vibrations of the air accompanying the said vocal or other sounds."

From the beginning, the success of the telephone as a public utility has been based much less upon a monopoly of patents than upon the creation of a thoroughly organized business with a high conception of the meaning of "service."

During the first half of the life of the Bell patents a large number of rival companies came into existence, attracted, no doubt, by the financial rewards which were apparently in view for a successful telephone system. The greatest of these competitors, as already noted, was the Western Union Telegraph Company. One hundred and twenty-five competing companies were launched in three years in open defiance of the Bell patents. Few, if any, except the Western Union, had any idea of supplying telephone service. Their securities bore a face value of $225,000,000 and were freely offered to the investing public. One company without patents or funds was capitalized at $15,000,000. It is estimated that, at one time and another, companies whose paper value was $500,000,000 were organized to break up the Bell system.

As the term of the fundamental Bell patents approached its end the practical monopoly which the Bell company had enjoyed since it acquired the telephone business of the Western Union again attracted competition and numerous "independent" exchanges were started in various parts of the country. Cities and towns which had not enjoyed the benefits of telephone service were the first to be supplied by the "independents." A large number of "rural lines" also sprung up in farming and sparsely settled communities. Later the larger cities were invaded and independent exchanges were to be found in successful operation in Chicago, Philadelphia, St. Louis, Cleveland, Seattle, Indianapolis and many other places. The best paying lines established by the independent movement were, however, those in the rural districts. A vast network of exchanges and interconnecting lines was created and a considerable number of manufacturers of independent apparatus went into business.

Previous to this time the Bell people had devoted great energy and foresight to the standardization of telephone equipment. Now the market was flooded with apparatus of all sorts and designs. In many places the business man was forced to use two telephone services — the Bell and the independent—with all the lost motion and inefficiency which such a situation involved. In this way, under the guise of competition, the waste of duplication began generally throughout the country. In a few years after the expiration of the original Bell patents there were over 6,000 independent companies, little and big. By 1901 there were more than 1,000,000 independent telephones in use. The fact that the great majority of these independent companies survived and continued to do business proved that they were necessary and that there was a demand for their service. They did a great deal toward expanding the telephone business into new territory. Some of them built up complete plants and gave good local service. The people in many cities came to regard the establishment of a duplicate telephone system as a desirable innovation, and one promoter observed that "we have two

ears. Why not have two telephones?" Herbert N. Casson refers to this phase of telephone history as follows:

"This duplication went merrily on for years before it was generally discovered that the telephone is not an ear, but a nerve system; and that such an experiment as a duplicate nerve system has never been attempted by Nature, even in her most frivolous moods. Most people fancied that a telephone system was practically the same as a gas or electric light system, which can often be duplicated with the result of cheaper rates and better service. They did not for years discover that two telephone companies in one city means either half service or double cost, just as two fire departments or two post offices would."

An investigation made in twelve single-system cities and twenty-seven double-system cities demonstrated that there were about eleven per cent more telephones under the double system, and that where the duplicate system is installed every fifth user is obliged to pay for two telephones. The rates were alike, whether the city had one or two systems. Duplicating companies raised their rates in sixteen cities out of the twenty-seven and lowered them in one.

The independent telephone movement was undoubtedly for several years a stimulant to the Bell company and its subsidiaries; but it did not bring to its promoters the promised cheap rates, improved service and big dividends. Nothing new in telephone apparatus resulted from it except the automatic switchboard which, however, is not found in service in Bell exchanges even today. The movement may be called a progressive one among the rural population and reactionary in the cities.

The independent companies began to appreciate the limitations of their isolation and by 1907 asked to be linked up with the Bell system. In that year the Bell companies took over 458,000 independent telephones and 350,000 more in the following year. This experience has been repeated from year to year until at the present time the Bell companies are furnishing practically the entire telephone service for the whole country. Throughout the farming districts of the United States there are thousands of groups of farmers with a mutual telephone system all connected to the vast network of the Bell system so that they are in as close touch with the big cities as they are with their neighbors.

Theodore N. Vail, who had practically created the telephone business from the

The Blake Transmitter
Invention of the late Francis Blake

commercial side in 1878, had been for twenty years in South America engaged in public utility projects of his own. In 1907, just as the independent movement was beginning to realize its isolation, he accepted the presidency of the associated Bell companies to push forward to final success the completion of the universal telephone system which he had visualized when the telephone was only three years old.

The development of the art of telephony in the United States, for the purposes of a bird's-eye view, conveniently may be divided into four periods as follows:

1876-1886. The Period of Experiment. Probably the most prolific decade in the invention of fundamentals. Every telephone man was a law unto himself. There were few engineers and no experts. The period of iron wire, tentative appa-

ratus, peg and similar switchboards, local batteries and overhead lines.

1886-1896. The Period of Development. Amateurs became engineers. Proper apparatus was discovered and developed to high efficiency. The period of the multiple switchboard, girl operators, copper wire, underground cables, common battery system, metallic circuits and long distance lines.

1896-1906. The Period of Expansion. This was the harvest time in which the men behind the telephone and the public began to reap the results of twenty years of hard work and financial investment. The period of message rates, pay stations, farm lines and private branch exchanges.

1906-1916. The Period of Organization. With the increasing use of the long distance service the telephone became more national in character. It taught the telegraph to cooperate. It got itself in closer touch with the desires and needs of the public. It organized for standardization, efficiency and service.

The Bureau of the Census, of the United States Department of Commerce and Labor, first recognized the telephone industry in 1880. The published figures for that year, while incomplete, show that there were 148 telephone systems in operation, serving 48,414 subscribers over 34,305 miles of wire, through 43 public exchanges. The par value of the authorized capital stock of all the companies was $17,386,700, of which $15,702,135 was outstanding. This whole business was carried on by 3,338 employees.

The last annual report of the American Telephone and Telegraph Company, as of December 31, 1917, shows that on that date there was one Bell telephone station to each ten of the total population of the country. There are in the United States approximately 11,200 separate companies giving telephone service. Of them 37 are Bell companies, 9,129 independent companies connecting with the Bell system, and about 2,000 independent companies not connecting with the Bell system. There are also a large number of rural lines and systems which connect with these companies, 22,299 of which are connected with the Bell System.

At the end of the year the number of telephone stations which constituted the Bell System in the United States was 10,475,678, an increase during the year of 628,486, of which increase 486,040 were owned by the Bell companies and 142,446 were Bell connected stations. Of the total number of stations in the system 7,031,530 were owned and operated by Bell companies and 3,444,148 by local, cooperative and rural independent companies or associations having sublicense or connection contracts; the socalled connecting companies.

In addition to these there are about 1,300,000 stations operated by independent companies not connected with the Bell System.

The assets of the company totaled $1,276,503,468. The capital stock outstanding was $505,403,777 and the funded debt was $407,434,080. The surplus and reserves amounted to $303,525,651 and the employees' benefit fund was $9,219,143.

In 1900 the net revenue of the company was $5,486,058, of which $4,078,601 was paid in dividends, $937,258 was added to reserves and $470,199 was added to surplus.

In 1917 the net revenue of the company was $50,714,211, of which $36,862,582 was paid in dividends and $13,851,629 was added to surplus.

The range of speech over long distance telephone lines was for a long time limited by detrimental electrical effects of a character unavoidable in the use of insulated wires twisted together in pairs, in which the wires are in close proximity to each other and to other pairs of wires forming the same cable. As an example, the loss in speech transmission in one mile of No. 19 B. & S. gauge wire, with a diameter of .0359 inch, in cable of the ordinary type, is equivalent to that in a little more than eight miles of No. 12 B. & S. gauge copper wire, diameter .0808 inch, strung as an overhead metallic circuit on poles with the standard spacing of 12 inches between the two members of the circuit. As practical efficiency and economy require the use of cables, instead of a multitude of overhead exposed metallic circuits, it will be seen that the problem of overcoming these retarding electrical effects was of the greatest importance. It was solved in a most ingenious manner by a mathematical inves-

tigation carried out by Dr. M. I. Pupin, of Columbia University, New York City, who took out a number of patents covering the method which he evolved. Under the direction of Mr. John J. Carty, chief engineer of the American Telephone & Telegraph Company, and his staff, Dr. Pupin's method was placed on a practical commercial basis and at present conversation between New York and San Francisco is carried on largely through the use of lines which are "loaded" at intervals with the Pupin device. The transmission over a loaded No. 14 B. & S. gauge pair of wires forming part of a cable, such as is used in the long distance circuit between Chicago and Milwaukee, 88½ miles in length, is as good as would be obtained over an unloaded cable circuit which uses wire of the same size but is only 18 miles long. The practical effect of installing this type of loaded cable for circuits of this kind is to protect the wires from the influence of the weather, which on overhead wire lines might at any time absolutely interrupt the important service given, or reduce the efficiency of transmission. The conditions of the cable circuit are practically constant, so that their installation represents an exceedingly valuable improvement in the facilities for handling a traffic consisting of important messages, heavily concentrated between two points. Loading overhead long distance telephone lines also has reached a high stage of development.

For a long time after the first telephone lines were installed, a circuit consisted of a single wire extending from a grounded terminal at the central office to a ground connection at the distant terminal of the telephone instrument at the subscriber's station. The electric current followed the wire and completed its circuit through the earth. Such grounded circuits were used to a large extent between central offices for the transmission of messages from one exchange district to another, but later were replaced with metallic, two-wire lines, to secure improved transmission.

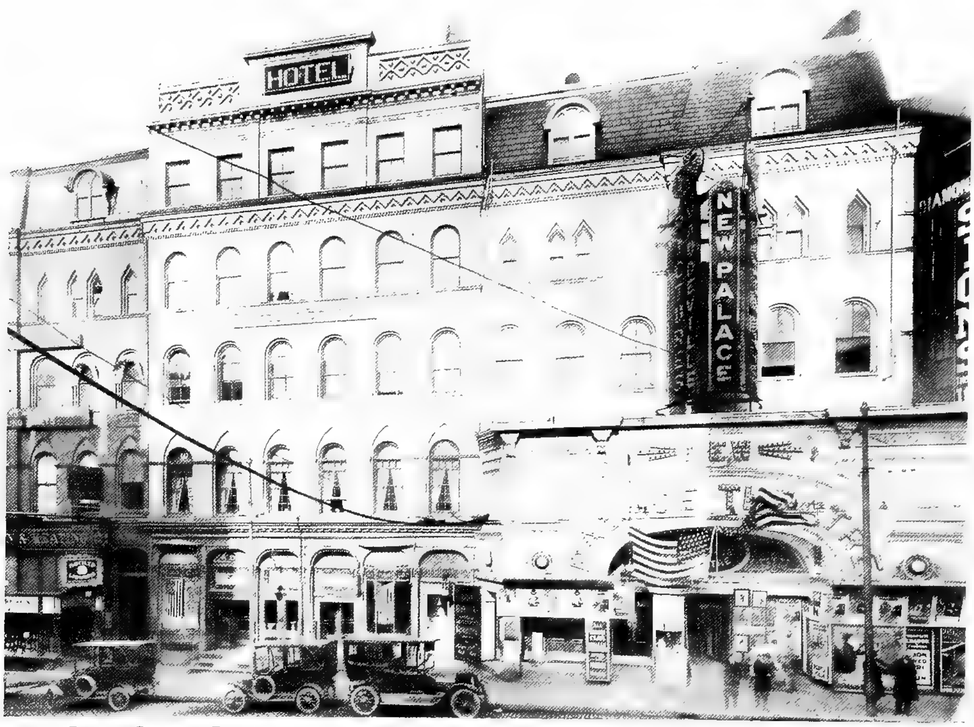
The copper wire which carries the messages forms a large proportion of the fixed investment in a long distance telephone system. In the early days the revenues from long distance business were limited by the inability to use the two wires of a line for more than one message at a time. Several important inventions which were commercially developed about 1905, made it possible to use two pairs of wires to carry simultaneously three telephone messages, the lines being adapted for this service by the connection of special coils of wire wound upon iron cores at each end of the respective circuits. Not only is it possible to use a pair of wires to transmit a telephone message, but at the same time a telegraph message may be sent over one of the wires, or each of the two wires may be used to carry a separate telegraph message, without interfering with the telephone conversation which is at the same time passing over the circuit. The highest development of this remarkable achievement shows that, through duplex and quadruplex telegraphy, four or eight telegraph messages may be transmitted over each pair of wires without interfering with their use as a talking circuit.

By means of inductance and other electrical actions, it is possible to create a third circuit without stringing any additional wires. As this third circuit has no physical existence apart from the two original pairs of wires, the early inventors called it a "phantom" circuit, a most appropriate name and one now constantly used. Besides the coils and a small amount of special wiring at the ends of circuits, the only additional investment required to produce a phantom circuit is that necessary for a rearrrangement of wires on poles at intervals throughout their length to prevent confusion of speech in the lines. It is impossible, however, to create a phantom of two circuits which are not absolutely similar. A copper circuit and a pair of iron wires might be of the same size and length, but the differences in the molecular character of the two metals would prevent them from being combined to produce a good phantom circuit. It is also necessary to keep wires which are phantomed especially clear of trees and other influences which would tend to reduce insulation. Such circuits must be kept in first-class condition. In spite of the extra care required, this device has made, in the aggregate, thousands of miles of lines more profitable than before its adoption, by adding a potential advance in returns of 50 per cent at the cost of a comparatively insignificant

investment, with no harmful effect upon the service.

Telephone companies now carry on a large part of the communication relating to their own business by telegraph, over circuits which at the same moment are earning revenue by carrying messages for subscribers. For a long time one of the elements entering into the cost of long distance telephone service was the use of the wire by operators in making appointments necessary for completing connection previous to the establishment of communication between subscribers. Where the necessary information is transmitted by telegraph over a phantomed telephone circuit, one paying message can follow another as rapidly as the wire can be released. By leasing the use of a telegraph line formed in this way to outside persons, a telephone company may at any given instant be deriving from a particular pair of wires income from three separate persons—one telephoning, a second leasing one wire of the pair, and a third leasing the other wire, the two latter being users of telegraph service.

The wireless telephone, although it has not been regularly applied to commercial service, has been repeatedly demonstrated practically and represents, from a scientific standpoint, a valuable addition to the art of speech transmission. The principle upon which it operates involves the modulation of continuous trains of electro-magnetic waves, in correspondence with the intricate variations of sound waves which impinge against the diaphragm of a transmitter. These electro-magnetic waves, at the receiving end, pass through a detector which gathers out the variations and retransforms their special type of energy into variations of electric current capable of causing vibrations in the diaphragm of a telephone receiver and thus reproducing speech. Although there is no commercial wireless telephone service in existence today, speech has been success-



109 Court Street, Boston *Courtesy of A. Arthur Ziegler*

The Birthplace of the Telephone as it Appears Today in Contrast to the Original View on Page 50

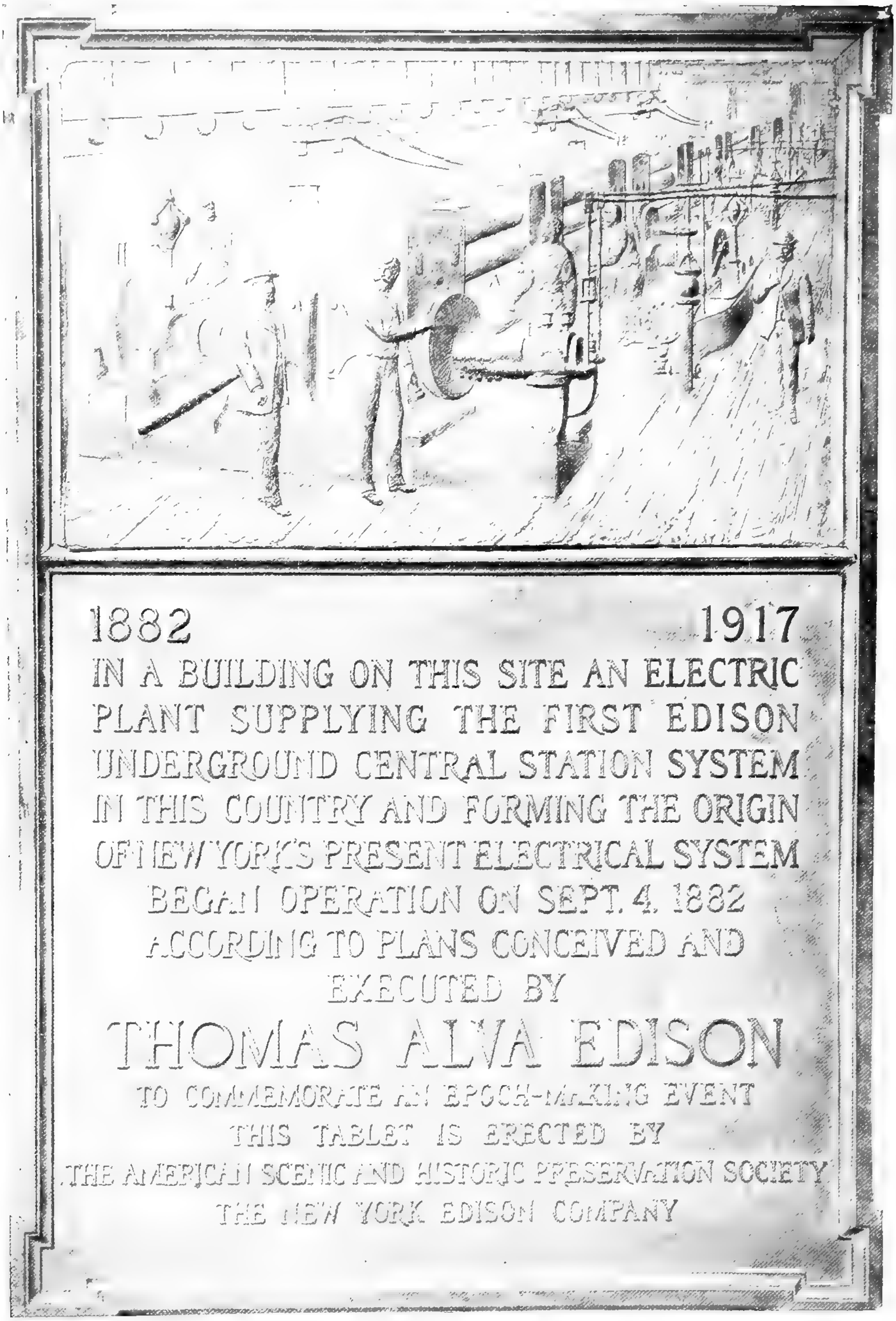
fully transmitted by means of radio communication across the Atlantic Ocean from Washington to Paris, and from Washington across the North American Continent and over the Pacific Ocean as far as Hawaii. Telephone communication has also been established with a battleship at sea, in which the land lines of the Bell System were used in combination with its radio telephone system, which bridged the gap between the seaboard and the ship. Studies, based upon these and many other tests, have indicated that the true field of wireless telephony is to extend the wire system to points where telephone wires cannot be constructed and maintained, rather than for uses where wire systems can be employed.

No single factor has played so great a part in the amelioration of the conditions of farm life in the United States as has the telephone. Many hundreds of thousands of telephones are today installed in the farm houses of this country—so many and so widely distributed that it is next to impossible to secure accurate statistics of their number. The National Bell Telephone Company, in a rate circular issued April 26, 1879, recognized in a prophetic, anticipatory way the needs of these isolated communities in the rural districts. Special rates were made for lessees of a telephone "for use between residences when connected on a single line or circuit for social purposes exclusively." Another rate was given for leases for "club purposes," which were defined as covering cases where the residences, offices, etc., of different parties were connected on any single line or circuit. These were not exchange telephones, but represented an attempt to serve a purely neighborhood group. Under this form of lease a group of farmers could establish a line and each talk with all the others on the same line, although, as they were not connected to an exchange, they could not talk with any person connected to another line.

The late Morris F. Tyler, when president of the Southern New England Telephone Co., operating in Connecticut, about 1881 began to develop this kind of telephone use and carried it to its next logical step, the connection of these lines to the nearest exchange belonging to the company. An annual rental was charged for the use of the instruments and lines within the group of neighbors, because in Connecticut the lines had been built by the company and not by the farmers. A small toll charge also was made whenever any of the club subscribers desired to reach the exchange with which their circuit was connected.

This was the beginning of the development of telephone service in the United States outside of the strictly urban districts. The methods above described were soon utilized in other parts of the country. During the next few years, however, comparatively little was done to push this form of service, as the extraordinary demand for telephones in the cities and larger towns not only took all the time and attention of the executive but made such demands upon financial resources that it was impossible to devote any money to the development of rural service.

In 1893, after the expiration of the fundamental patents on the telephone a number of companies began the manufacture of telephone instruments. Inasmuch as the demand in the cities was at that time fairly well met, these manufacturers undertook to aid in the development of rural lines as a market for their instruments. The movement was successful and the number of telephones on farms was greatly increased. The growth has been constant ever since.



Photographic Bureau New York Edison Co.

Memorial Tablet unveiled at the New York Electrical Exposition Oct. 18, 1917. Now Permanently Located on the Site of the first Edison Generating Station at 257 Pearl Street, New York

CHAPTER IV

THE CENTRAL STATION

The Birth of Commercial Activity in Electric Lighting
The Rivalries in a New Industry.

WHAT would the Story of Electricity be without the Story of the Central Station? Surely, it would be minor in detail and devoid of much that fascinates and interests the student of electricity of today.

In the midst of the magnitude of the electrical properties of today it is hard to carry the imagination back to the time when no central station existed or had even been conceived—a time of only the span of one generation and well within the memory of men still living and active.

The First Central Station.

The year 1882 marks the constructed conception of the first Edison station—the first to fulfill our present conception of a *Central* Station, that is, a source of electric supply, divisible for sale to each and all for every use. The standard of that station was not maintained in some few succeeding years but its salient features originated and still constitute the most primary and vital features of Central Station practice to this date, which is an extraordinary tribute to the inventor, the more so when one realizes the state of the prior art.

For the preceding eighty years a series of apparently unrelated electrical discoveries had been an aimless progress with no commercial impetus. Steam as a motive power had become available through the invention of the steam engine by Watt in 1769. Dynamic electricity, as generated by chemical batteries, was discovered in 1800. The dynamo originated in 1831 with the discovery of electro-magnetic rotation by Faraday. He demonstrated it by the spinning of a little copper disc between the poles of a permanent magnet. (The armature was first wire-wound and the first commutator built in 1832 by Pixii. The field was first energized by a wire-wound electro-magnet in 1845. The dynamo field was first made of the multipolar type and the fields first compounded in 1881.) The arc light was first produced in 1802 by Davy and it was first publicly exhibited by him in 1810, chemical batteries furnishing the necessary current. These lights attained little commercial importance until 1876, when Chas. F. Brush completed his "system" of dynamo, arc lamps, regulator and accessories. The Thomson-Houston "system" was completed likewise soon afterward. (The electric motor was built first in 1833, antedating the dynamo, and a motor built in 1838 propelled a small boat.) Various motors were built in the following years, but not in a large, commercial way until the introduction of the Sprague motor in 1884. The incandescent lamp of high resistance type, the basis of modern illumination, was invented in 1879. A miniature electric railway carried passengers at an Exposition in 1879. The first storage battery, then called a "box of electricity," was built in 1881. No units of electrical measurement were authoritatively defined until the Paris Electrical Congress of 1881 adopted the ampere, the ohm and the volt. These various advances then had no commercial importance. All the devices were built of small size and were not suitable for commercial use. The

familiar construction materials of today were not available, the inventor had even to insulate his own wire.

The Birth of Commercial Activity.

The Centennial Exposition at Philadelphia in 1876 marked the birth of commercial activity in electrical enterprises. No such activity had existed previously except in the telegraph.

The telephone invented by Bell was first exhibited to the public at the Centennial Exposition in 1876. Great public interest was aroused. Commercial expansion required something more than the telephone alone; that is, it required the counterpart of the central station, or the telephone exchange. The first exchange was built in 1878, and from that date to this the expansion in the use of the telephone has been no less marvelous than that of its kindred, the central industry.

The arc light was the next electrical application to secure a commercial start. More illumination in public streets than gas afforded was needed; arc lights became the new fad, and hundreds of street lighting plants were built, supplying cities and towns everywhere. The movement had its greatest force from 1880 to 1893, or up to the time of the Chicago Exposition.

The development was accomplished by "systems"; that is, each inventor, dozens of them, invented his particular dynamo, arc lamps, regulators and accessories, known as a "system," each exploited by its particular manufacturing company, and all competing intensively with each other. Each local company was organized to secure, or organized on the basis of having secured, *one* contract; that is, the municipal street lighting contract of its own city. The contracts were for street lights of "2,000" or "1,200" candle power, later qualified as "nominal," and otherwise much of the form still prevailing; that is, for periods of one to ten years, for hours of the night from at or near sunset to at or near sunrise, or to 11 P. M., or to 12 P. M., or excepting moonlight hours, variously called all night, half night and moonlight schedules, each with various qualifications. These companies owned, operated, maintained and trimmed these arc lamps, mostly located in the streets, a few in stores and public buildings, and sold *light* as distinguished from electricity. These companies formed the nucleus, however, from which in later years was developed the central station industry.

The hours of lighting fixed the hours of station operation, varying from 1,500 to 4,500 hours per year; hence, they fixed many expenses. The idle, non-revenue daylight hours of the many arc street lighting investments were an acute handicap to a great body of ambitious men who wanted to broaden the service; and this handicap operated later, more forcibly than any other visible conditions, to stimulate and co-ordinate electrical undertakings and to crystallize them into the modern central station.

Edison was finishing his brilliant inventions in the telegraph field when the arc lighting systems were being exploited, and turned his attention to incandescent lighting, power, railway and other applications of electricity. He was active in various directions, building a dynamo in 1878, but his crowning invention on October 21, 1879, was the high resistance incandescent lamp, the first incandescent lamp built for parallel operation. This was called "dividing" electricity, in the phrase of that day, and created the greatest public interest and excitement. The system was condemned by many leading scientists, otherwise very competent men. This "dividing" of electricity made a permanent impression on the public mind. Today it is the standard of distribution the world over. As the champion of the divided supply of electricity, and with his small incandescent lamps, Edison proceeded with the greatest courage to put his conceptions into concrete expression.

Two Edison stations were started in 1881-2. One in New York City, operated by steam; the other, in Appleton, Wisconsin, operated by water power. The station designer of today who has to select an appropriate collection of apparatus to be contained in a suitable building, does not realize what designing meant in those days. With little or no precedent for a guide Edison had to conceive the necessities, invent, design and build not only the dynamos but the station rheostats, switches, ammeters, voltmeters, regulators, fuses and all the numerous other things required

within the plant. Nor did his labors stop there, for he had also to create all the various devices required in the distribution system, including fuses, switches, sockets and the like. And the miracle is that he made a complete workable system.

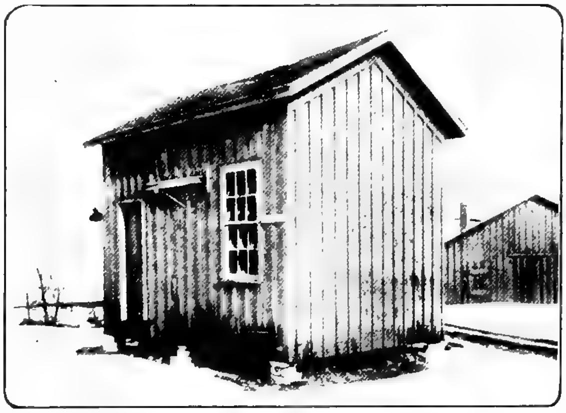
The New York station of 1882 operated in "parallel" at 110 volts direct current, the engines were directly connected to dynamos, the boilers were water tube type, Babcock & Wilcox make, and the distribution system was underground. (Strange, is it not, that this first American central station initiated some of the best practice of today, thirty-seven years later, when over 5,000 central stations are operating in the United States.)

The Edison system was installed in some scores of cities during the next few years. All these early Edison plants operated incandescent lamps almost exclusively. The current could be measured by meters of an electrolytic type, but not many plants used them. The meter plates were weighed and the deposit of metal was expressed in "lamp-hours." One cent a lamp hour was considered a very fair charge, equivalent to about 14 cents per kilowatt hour (our familiar friend, the kilowatt hour was not christened or legal until 1893-4). Most lamps were charged for at a monthly rate. In form, then, the early Edison stations sold *illumination*, and not current. Arc lamps were rare on these circuits.

The Sprague motor for Edison circuits was first produced commercially in 1884. The introduction of these motors was the first distinct broadening of the Edison commercial field. The service was suitable for a great variety of uses, and in a way, although a minor one, was beginning to determine a wider usage.

The commercial situation had developed to this point in 1886. The arc light companies located in every city could extend their circuits for some miles and reach every part of the city, but only could sell arc illumination and were hungry for a wider field of service. The Edison Companies located in few cities only, could supply in principle every need with the 220-volt direct current service, but could deliver current only a short distance, a very few thousand feet from the station.

The foregoing situation was revolutionized by the next development. The first alternating current system with transformers and parallel distribution built in this country was constructed in 1885 at Great Barrington, Mass., by William Stanley. The Westinghouse Company had initiated the development in this country. The arc

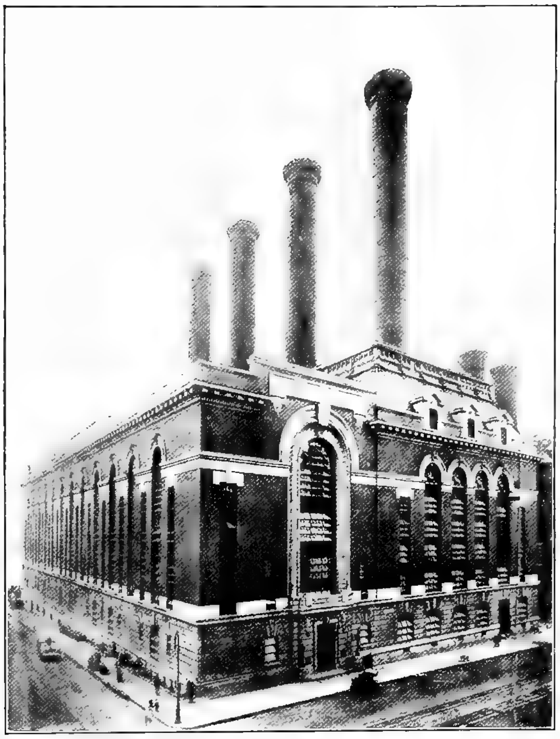


Edison's first Generating Station at Appleton, Wis.

light companies quickly recognized the opportunity to add indoor incandescent lighting to their service, and within a few years hundreds of high voltage alternators were set up alongside the older arc dynamos, primary wires erected alongside the arc circuits, and alternating current distributed for incandescent lighting without those limitations of distance that were so restricting to the Edison companies. The arc companies had now made the definite start toward furnishing a complete central station service. The allied modern hydro-electric development was started in 1890 by building a long distance line in the West to transmit alternating current from a water power station. All these earlier alternating systems were of high frequency; that is, 125 or 133 cycles per second. Integrating watt meters to measure the sales of alternating current became available with the inventions around 1888 of Shallenberger and Thomson. One more great invention was necessary to start the unification of these various electric systems and to promote the universality of electric supply.

Nikola Tesla had been annoyed in some early work by the sparking of a dynamo commutator and his study of such phe-

nomena was to be rewarded by one of the greatest of inventions. The fruition came in 1888 with his polyphase apparatus giving us the commutatorless alternating current motor, with better means of extending the limits of transmission, and of correlating the work of alternating and direct currents without restricting the usefulness of either. The invention of Tesla marked a great step onward, but was not fully appreciated in the midst of other activities



The present Central Station of the New York Edison Co.

of that date or of this. Thereafter hydro-electric developments had a new and incalculable value.

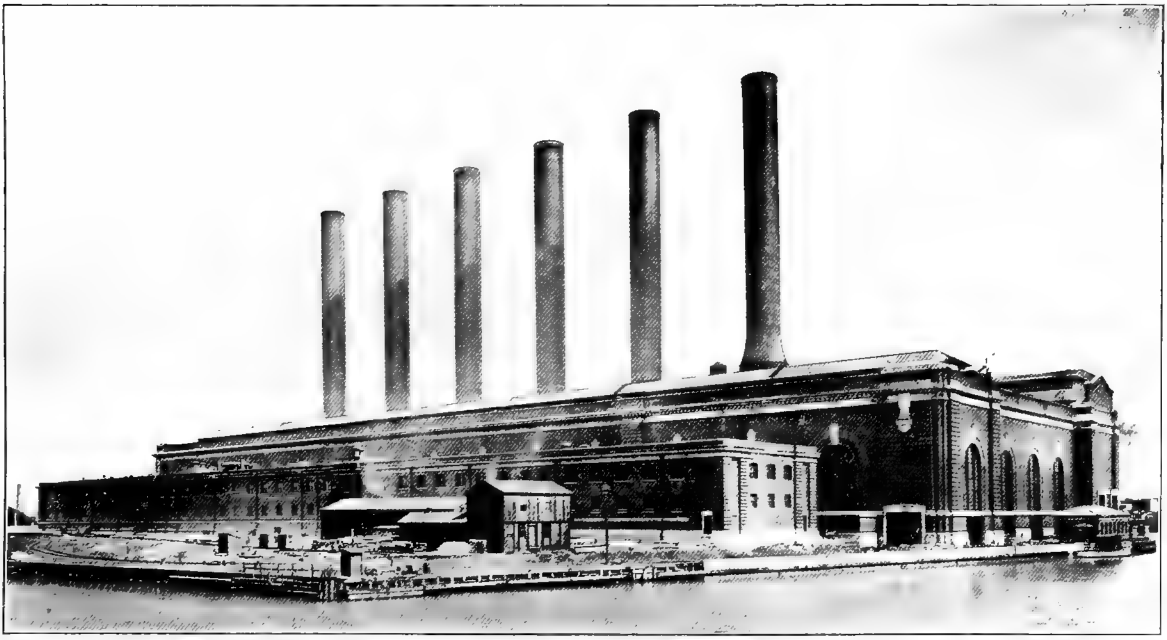
Central station progress can hardly be understood without some knowledge of concurrent commercial conditions. In the earlier years there had been great rivalry among the arc systems, and these then had little in common with the Edison system. The electric railways had nothing in common with either. The telephone companies sought to prevent the introduction of electric railway systems with grounded circuits, as these nearly ruined the telephone service which then operated also with grounded circuits. The Edison interests opposed the introduction of high voltage alternating systems then insulated with some uncertainty, and sought patent control of incandescent lighting. But this manufacturing rivalry and patent litigation had to yield to the compelling force of central station progress. The Thomson-Houston Electric Company, then having acquired control of most American arc systems, and prominent in electric railway installation, and the Edison General Electric Company, always the great champion of low voltage direct current supply, consolidated in 1892 to form the present General Electric Company. The latter in turn agreed with the Westinghouse Company, at that time, as now, a distinctive leader in alternating work, to pool patent rights, and thus the field was cleared for the next stage of central station growth.

The unification of electric supply, that is, supplying from one station and one type of generator electricity for each and every purpose, had become possible with the preceding inventions; manufacturing and patent interests had been harmonized to an important degree, professional relations were more friendly, and the ten years from 1893 to 1903, while partly years of business depression, were marked principally as the active years of developing central station inventions and methods and absorbing them into general practice. Central stations were becoming larger and more truly performing their full functions. Many such plants were built. At the same time further needed inventions were made. One in particular helped to simplify station design. The old "open" series arcs had required numerous small dynamos in the stations, these dynamos not ordinarily exceeding a capacity of 25 kw. These dynamos had been driven by steam engines, later by electric motors, in both cases crowding the stations with small units. With the invention of "enclosed" arc lamps, current was taken from the main generators, without its mechanical transformation, the small generating units were abolished, and generating units were consolidated. Many engineering practices were also standardized and developed. The periodicity of alternating circuits became standardized, generally at 60 cycles per second, in lieu of the earlier higher frequencies. Transmission potentials in-

creased from ten up to sixty kilovolts and distances of transmission from thirty miles to over one hundred miles; and the practice of delivering current to substations became common. The uses of electricity broadened in character and increased in volume.

All these conditions helped the central station industry immensely. The direct connection of generator to engine became the established practice. Previously, for various reasons, electrical and otherwise, belted generators were the practice, notwithstanding the fact that the original Edison station in New York was designed and built with direct connected "Jumbo" units. The growth of switchboard practice to handle a greater energy and higher voltages was another feature. The higher transmission voltages permitted the building and use of hydro-electric plants at increasing distances. Lighting stations, so-called, began to supply street railway current. In general, the central station industry began to be unified, not only by intention but by accomplishment.

Incandescent lighting had been established with the carbon filament lamp, and in the course of its use from 1882 to 1906 no marked increase of efficiency had been effected, (its current consumption had been reduced from somewhat over four to somewhat under three watts per candle. Nevertheless its great convenience and the smallness of units maintained its position for indoor use against the far more efficient arc lamp.) But in 1906 the tungsten filament lamp was introduced, and later the nitrogen filled lamp, these having some three times the illumination per watt of the carbon lamp. (A prejudicial effect was feared, namely that the central stations would suffer decreased electric consumption and correspondingly decreased earnings. Fortunately these lamps so stimulated illumination that on the other hand electric sales have increased tremendously, stabilizing and swelling the central station income.

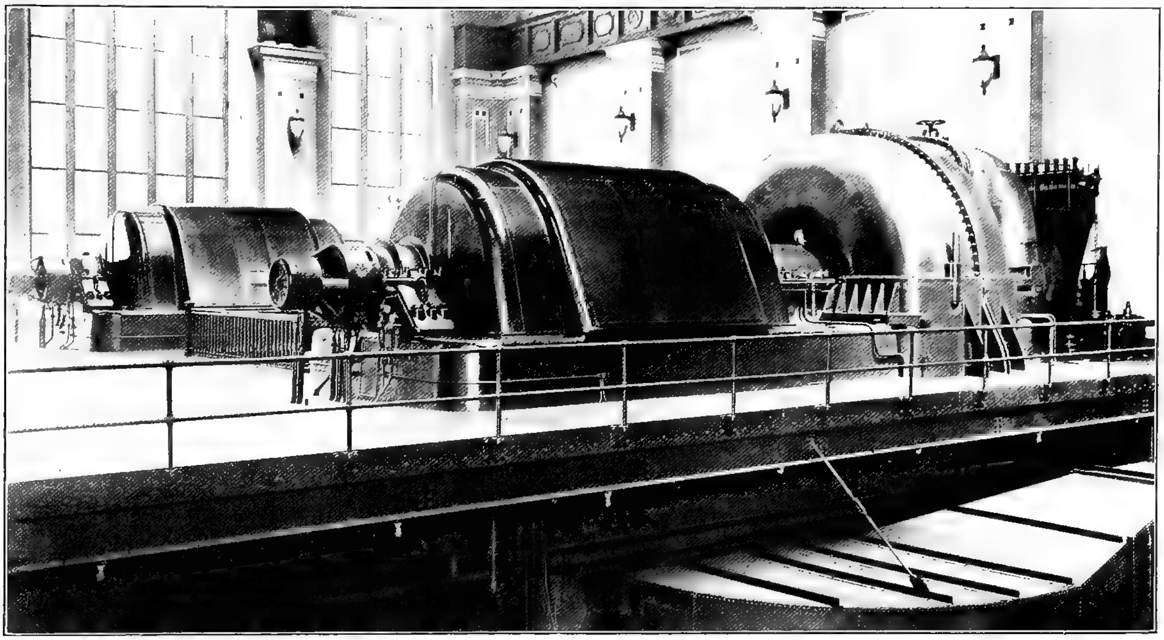

The Fisk Street Station of the Commonwealth Edison Company of Chicago, Ill.

No great inventions in electric motors, other than those of Tesla, had occurred since the central station industry started, but the advances in engineering design, the decreased cost, the application to new uses, the constantly growing appreciation of their convenience and economy, all pushed by aggressive managements of the local companies, had caused stationary motor consumption of current to increase at a higher rate than that of lighting current.

The growth of central station output due to the cumulative effect of more and more lighting, motor service and other

uses, combined with larger areas of supply, had reached such a point by 1903, that the more important local companies could not get engines large enough to keep the generating units in a station within the limits preferred for the best economic results. At that time steam turbines of a few hundred kilowatt capacity had been developed to drive electric generators, and a few had been installed in central stations. It was not then realized what a part the steam turbine would soon play in the larger central station practice. At last one courageous captain of industry insisted on a five thousand-kilowatt unit, and the rest of the story is short. The first all-turbine central station was built in 1903 in Chicago with 5,000 kw. units. To-day 35,000 kw. units are available, and I suppose larger ones could be built if needed. Mechanical and electrical limitations on the size of central stations are now remote so far as any present or prospective need is evident. Likewise boilers are larger, steam pressures are higher, vacuums are better, steam is superheated, and many other improvements have been made. Not only has the steam turbine removed restrictions of size for central stations, but it has reduced the steam consumption per kw. hour about one-half. Realize what this means as the furthest present reach in the expansion of the industry. The earlier stations were often under 100 kw. capacity, the latest approach 200,000 kw. capacity.

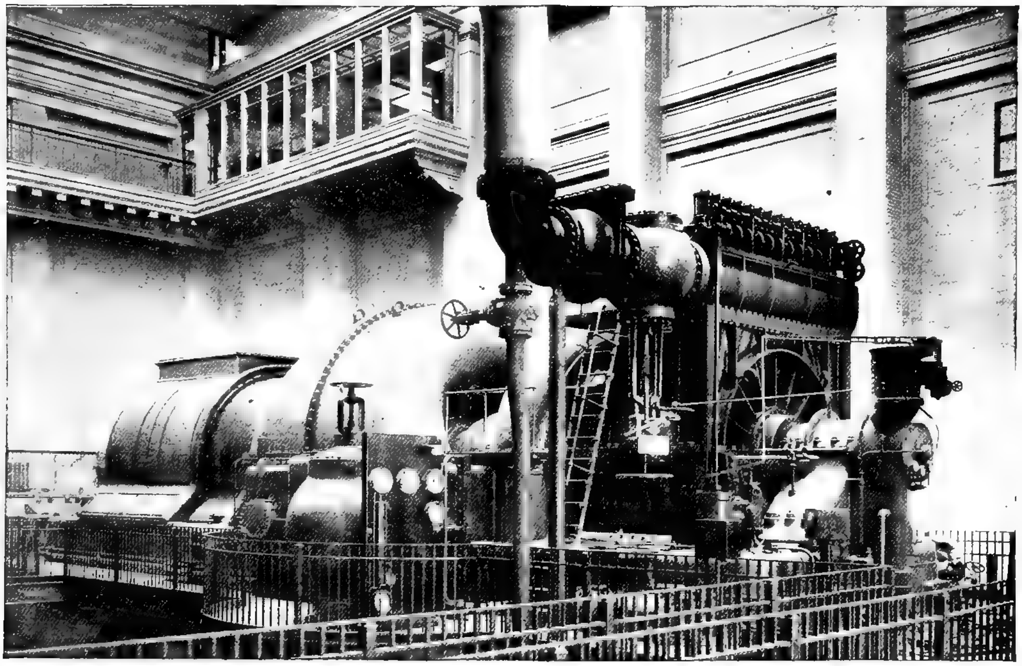
This review has dealt with the stages of progress, their causes and living economic results rather than with the four station walls and the throbbing masses therein of steel, copper and insulation wrought into such mysterious usefulness. A few words about station practice is interesting.



Interior of a Modern Power House—The Essex Station of the Public Service Company of New Jersey, Two 25,000 KW Curtis Steam Turbines

The location of the earlier station was close to the "load," without regard to coal deliveries by rail or condensing water supply. The outputs were diminutive, hours short, and engines non-condensing. The housing of the earliest stations was often in the cheapest wooden structure, sometimes partly of corrugated iron, sometimes a basement or other factory space, occasionally a brick building, and never with any architectural effect. The steam supply came from horizontal return tubular boilers, with cheap iron stacks, in sizes of 75 to 125 h.p. and operated at about 80 lbs. The motive power was secured from high speed engines, horizontal, center or side crank, of 60 to 125 h.p. and with economies, low at best, dependent on valves of

uncertain tightness. The dynamos were all belted; those for Edison incandescent system were of 30 to 60 k.w. each; those for arc systems, of 30 to 50 lights (15 to 30 kw.) each; those for railway, of 60 or 62 kw. each. The switchboard instruments had wooden backs and were screwed to wooden frames or walls. No watt meters were available to measure output, nor any recording instruments. As stations grew there followed an uncomfortable multiplication of boilers, engines and dynamos. The above represented ordinary practice up to 1903 with important exceptions. The Edison station practice was much more advanced; it had better engineering talent and more opportunity to use it. Many of the larger arc stations began to use Corliss engines and countershafts after 1893 to drive groups of dynamos. As outputs grew, stations were located alongside railroad spurs and accessible to condensing water. All these practices improved gradually in the aggregate as new stations were built and old ones reconstructed and consolidated. By 1903 good practice in new stations required water tube boilers, 140 lbs. working pressure, compound condensing engines, 26 inches vacuum, direct connected generators and marble or slate switchboards, all housed in a fireproof station of attractive design. Station outputs were outgrowing the economic capacity of steam or gas engines, and the steam turbine came to the rescue. Those built about 1900 were of 100, 200, then 500 kw. capacity; in 1903 they jumped to 5,000 kw. capacity and now to 35,000 kw., as previously stated.



35,000 KW Curtis Steam Turbine in the Central Station of the Philadelphia Electric Company

The condenser usually of the jet type for steam engines gave all needed vacuum at 26 inches. The highest possible vacuum is advantageous for turbines, and condenser engineering meets the need with surface condensers capable of 29 inches under stated conditions.

Stations today are untrammeled by internal conditions. Single boilers operated at well over 200 lbs. can furnish steam for not less than 10,000 kw. output. Single steam turbines will generate over 35,000 kw. The dynamo, formerly the conspicuous object in the station, is now lost among auxiliaries, transformers and switchboards.

Any needed output can be supplied, stations of one or two hundred thousand kilowatts are readily built. The problems are external. To find enough condensing water and coal storage are the essentials.

The feature of the last ten or fifteen years has been the great expansion of central station service. To make all the magnificent inventions permitting the creation of the industry has been a great task but one requiring the services of but few great men; to overcome the inertia of the general public, to educate it, to make it assimilate and absorb the invented appliances actuated by so unknown an agency, has been a greater task, and one requiring the services of many men of the most varied ability. It came to be realized by 1903 that small local service companies operating independently could not most fully serve their communities. Such a company could not risk the investment for the supply of power to the larger local manufacturers; it could not command funds freely for other extensions; it could not afford the many specialists needed for the intensive development of new services; its smaller station could not generate current cheaply; it could not afford the best engineers to keep down its expenses or to plan and direct its construction work. A continuation of these conditions would have throttled the industry. How has the situation been met? A large share, say four-fifths, of the present volume of central station business has been united under the control of perhaps 100 companies, either large ones within important cities or "Holding Companies." The latter are so designated as being the holders of the securities, or the property, of local operating central stations. These local properties are sometimes contiguous, and joined by transmission lines, sometimes largely in one State, or sometimes widely scattered through many States, but in any case one central management guides all, combines the purchases, finances the growth and standardizes the construction. In union there is strength. Compared with the separate local companies the "Holding Company" management is better, purchases are made in quantity cheaper, the financing is adequate, the construction is superior. In particular, the growth is stimulated intensively by specialists to the advantage of the Company and the still greater advantage of the public.

These big city companies and holding companies have extended transmission lines to interconnect steam and hydro plants and urban services until these circuits now form an almost continuous net work from Montreal to the Gulf of Mexico and thence to Chicago. Electric service is now visualized, not as bounded by urban limits but in state-wide terms. The movement came most opportunely. Not sooner. Could the large capital necessary have been secured, nor sooner could such able experienced and energetic men have been available for the work. The extension of electric service has been tremendously beneficial to the general public, although the value of the service and the effective labors of the "Holding Companies" have been little appreciated. This period should be considered as the latest and greatest of the central station industry.

The central station industry, unknown thirty-six years ago, was created by a few pioneers, often unrewarded for their work, which now ranks among the great services to humanity. Hardly a business or home but uses the electric supply. As an illuminant it preserves the purity of the air we breathe; as an ozonator, of the water we drink; as a heat source, of the food we eat. It conserves human and animal labor and does many things neither could do. It transmits power from its point of origin instantaneously to any selected point of use. Electricity is indispensable to modern life. Its usefulness cannot be measured.

The whole electrical industry in 1914 was exceeded by three industries only and was growing faster than they. The three were—food, textiles and iron. The values of electrical products were about half those of food, two-thirds those of textiles and two-thirds those of iron with steel.

Statistics afford a measure of the magnitude of the industry. Full census figures are not available earlier than 1902 nor later than 1912.

The investment in central stations, excluding electric railways and plants operated privately by factories, hotels, etc., was well over two billion dollars in 1912.

A tabulation of census figures for 1912, 1907 and 1902 gives the clearest picture of growth:

Each five years has seen a doubling of

Statistics.	1912	1907	1902
Output in KWH.	11,532,963,006.	5,862,276,737.	2,507,051,115.
Income in Dollars	302,115,599.	175,642,338.	85,700 605.
Generators in KW	5,134,689.	2,709,225.	1,212,235.
Av. Size in KW.	408.	223.	97.

The growth has been slight in number of

Stations	5,221.	4,714.	3,620.
Generators	12,597.	12,173.	12,484.

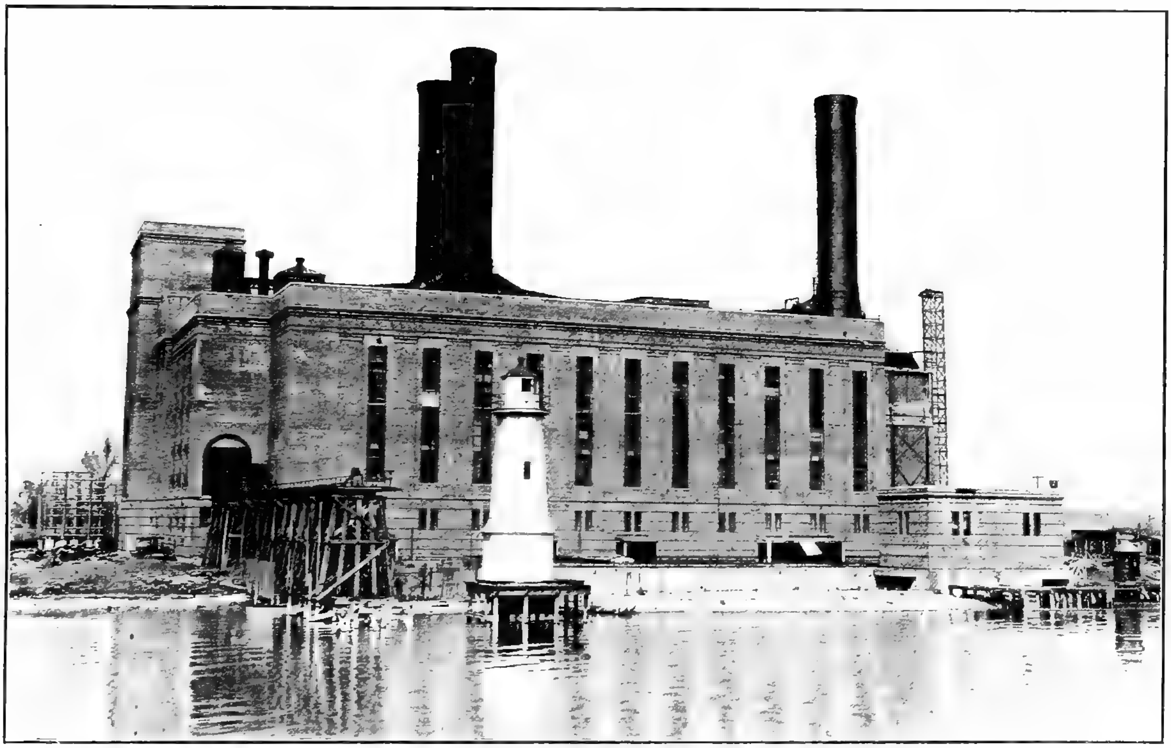
The entrance and adoption into the industry of alternating current generators (and their per cent in respect to other types) and of steam and water turbines is shown thus:

A. C. Generators..	4,661,199.	2,221,773.	736,304.
% to all types.....	91%	81%	61%
Steam Turbines..	3,054,456.	817,410.	nominal
Water Turbines..	2,471,081.	1,349,087.	438,472.

The connected load on all central (and railway) stations follows:

Arc Lamps......	560,981.	635,815.	419,561.
Incandescents....	85,557,819.	45,991,836.	19,636,729.
Motors	435,473.	187,652.	111,113.
Motor H. P......	4,130,619.	1,807,949.	473,693.
Meters	3,617,189.	1,897,803.	639,290.

The latest figures above are for the industry five years ago. In the subsequent six years to date the industry has grown as never before and it is believed these 1912 figures have again been doubled.



The River Station of the Buffalo General Electric Company
(A Descriptive Article of this great Station Appears on a later Page of this Volume)

The central station industry doubles, doubles and doubles again in magniture with such ease and quietness that scarcely anyone now appreciates the growth and its influence not only on industry but on our very civilization. It is becoming the predominating material influence as the basis of our civilization. The future sees no end to the growth of the central station industry. As respects territorial expansion, all urban homes and industries already have electric service. Many lines already join groups of cities and towns. Transmission lines are becoming continuous. As more water powers are developed the net work will grow. As more railroads are electrified the service will be spread immensely. Before many years every city and town, all important railroads and many farms will have electric service available. Do not the railroads and the farmers need it?

The great value of electric power for steam railroads has been most convincingly demonstrated on a large scale in recent years. The principal problem is the one of finance. For agricultural use there are

numerous applications to lighten the burden of the farmer. Invention and engineering practice are adequate already and it remains for our economic life to assimilate and apply a greatly increased volume of applications. These may proceed in an orderly and systematic way which may be foreseen and predicted as to character and extent, but not in rapidity, the latter depending on financial conditions. We may look forward confidently to the time a few decades hence when all factories, all steam railroads and many farmers will use electric service and innumerable other uses for power, heating, etc., will multiply station output. The central stations will then pump current into vast transmission net works from a relatively few stations of great size and economy, and the present output will be multiplied many fold. But what will the inventor do? Certainly not remain idle. Who can foretell the character of coming inventions? Fantastic conceptions are necessary to fit the case. Tesla may realize his dream of transmitting unlimiting power through terrestrial distances without wires and a fitting corollary would be to gather the energy from celestial space.

No other industry so enormous has attained such proportions in so few years. It has absorbed the life energy of many men. Dealing with so invisible an agency has required great and peculiar qualifications of its developers. To appraise their work adequately is impossible.

Edison is the father of the industry. He conceived the central station idea and embodied it in the Pioneer plant. He attracted able assistants, among them Insull, Kruesi, Andrews, Leonard, Lieb and Edgar.

Thomson and Brush aided the later rapid spread of the industry through the arc stations of their systems which took up the central station service.

Westinghouse first promoted the alternating system and Stanley installed the first alternating plant.

Tesla, by the polyphase current and the rotating field, made the first commercial alternating current motor, harmonized the conflict of types of apparatus and removed restrictions of distance in transmission.

Curtiss removed restrictions in size of stations by inventing that type of turbine with which the first all-turbine station was equipped, the type since so largely used, and Emmett has performed signal service in its development.

Coffin stands supreme as contributing more to create the magnitude of the whole electrical industry than any one or many men by his encouragement of invention along useful lines, by his financial powers, by his talent for organization, by his tireless energy, by his courage in introducing and his abilities in selling new apparatus.

For many years in large cities the long established Edison companies, now grown to enormous proportions, have been developed and managed by able men, such as Insull of Chicago, Lieb and Williams of New York, Edgar of Boston, Dow of Detroit, men who were pioneers in the industry more than thirty years ago, men who have worked with sound judgment, and contributed immensely to the promotion of the service. In later years the great holding companies that have spread the gospel of electric service far and wide so effectively have found their inspiration in such men as Mitchell, Doherty and Byllesby.

Sargent is the engineer who has led the way in the advance of central station design. Chicago is the location of the monuments, greatest of his creations and of all the world. Chicago knew no central station when we once worked there together.

Finally, but foremost, is Samuel Insull of Chicago. Starting as an aide to Edison before the first station was built, he has always been identified with the industry. Cumulatively, in recent years, he has typified what is biggest and best. Builder of the first all-turbine steam central station, now leader in many electrical enterprises, with rare vision and faith he is the bold pilot to a stupendous future.

Why cannot these constructive labors to conserve and enrich human life be appreciated and honored more publicly than the destructive efforts of many so-called social reformers.

It has been my great privilege to serve in this industry, to watch its birth and growth and to know all the men above mentioned (except two) and to know a number of them intimately.

THEODORE STEBBINS.

THE ORIGINAL RULES AND REGULATIONS ON ELECTRICAL FIRE HAZARD

The effort to control the electrical fire hazard in the city of New York by the Fire Underwriters dates back to the beginning of the commercial use of electricity as a source of light and power. Rules and regulations according to which electric wiring and apparatus should be installed were drafted by the Underwriters in consultation with the electrical interests as early as 1881. These rules have been regularly and periodically revised since that time in order to keep pace with progress in the art, and to meet developments found to be necessary by experience in the field.

It may be of some historical interest to place in this permanent record a complete copy of the Rules above referred to as having been drafted in 1881, and which were as follows:

NEW YORK BOARD FIRE UNDERWRITERS
(Boreel Building)
115 Broadway
Rooms Nos. 32 to 38
New York, October 19, 1881.

The New York Board of Fire Underwriters at a meeting held this day, adopted the following standard for Electric Light Wires, Lamps, etc., subject to future additions.

1. Wires to have 50 per cent excess of conductivity above the amount calculated as necessary for the number of lights to be supplied by the wire.

2. Wires to be thoroughly insulated and doubly coated with some approved material.

3. All wires to be securely fastened by some approved non-conducting fastening and to be placed at least 2½ inches for Incandescent lights, and 8 inches for Arc lights, from each other, and 8 inches from all other wires and from all metal or other conducting substance, and to be placed in a manner to be thoroughly and easily inspected by surveyors.

When it becomes necessary to carry wires through partitions and floors, they must be secured against contact with metal or other conducting substance in a manner approved by the Inspector of the Board.

4. All Arc lights must be protected by glass globes enclosed at the bottom to effectually prevent sparks or particles of the carbons from falling from the lamps, and in show windows, mills and other places where there are materials of an inflammable nature, chimneys with spark arrestors shall be placed at the top of the globe. Open lights positively prohibited.

The conducting frame work of chandeliers must be insulated and covered the same as wires.

5. Where electricity is conducted into a building (from sources other than the building in which it is used) a shut off must be placed at the point of entrance to each building, and the supply turned off when the lights are not in use.

Applications for permission to use electric lights must be accompanied with a statement of the number and kind of lamps to be used, the estimate of some known electrician of the quantity of electricity required, and a sample of the wire (at least three feet in length) to be used, with a certificate of said electrician of the carrying capacity of said wire. The applications should also state where the electricity is generated, whether the connection will have metallic or ground circuit, and as far as possible give full details of manner in which it is proposed to equip the building.

Applications should be sent to Wm. M. Randell, Secretary of the Committee on Police and Origin of Fires.

WM. W. HENSHAW, Secretary.

The National Electrical Code was originally drawn in 1897 as the result of the united efforts of the various Insurance, Electrical, Architectural and Allied interests; and is published by the National Board of Fire Underwriters and distributed free of cost to every one interested in the subject. These rules almost without exception form the basis of all State, municipal, or other electrical inspection department requirements throughout the United States and Canada, and are under the direction of the Electrical Committee of the National Fire Protection Association.

THE STEAM BOILER AND ITS RELATION TO THE ELECTRICAL INDUSTRY

The following article prepared on the Babcock & Wilcox Co. is particularly appropriate in this chapter on the Central Station.

By far the most important branch of the electrical industry is the generation of current for light and power purposes, and there is no industry so closely related to this branch as that of steam production. Electric generators are almost universally driven by one form or another of steam prime movers. It is true that within the past few years water power has been used to a greater extent as a source of energy for the generation of current, but a fact frequently overlooked is that, almost without exception, water power plants are supplemented by steam plants of equal capacity to obviate the possibility of interruption of service. Further, the modern steam plant is generating power as cheaply, if not more cheaply, than water power plants under conditions most favorable to the latter.

In 1878 and 1879 Siemens and Jablochkoff, in Paris, were demonstrating the practical application of electric current to lighting purposes, and in 1879 Brush and Thomson were developing arc lighting systems in this country.

Thomas A. Edison revolutionized electric lighting methods by the introduction of the incandescent light and a comprehensive system of generation and distribution of electricity. His experiments preceding the introduction of his system were conducted at Menlo Park, N. J., in 1878 and 1879, and it is of interest to note that the source of his power was a boiler of the water tube type rated at 75 horsepower and manufactured by Babcock & Wilcox, engineers.

Edison's incandescent lamp was first shown outside his laboratory in 1880, and in the late fall of that year the laboratory, workshops and many of the surrounding private houses were lighted each night by the new system.

In 1880 Edison equipped a building at Menlo Park for the manufacture of incandescent lamps, and for a period of some months the light and power was supplied to this factory from the laboratory by an overhead line. In the early part of 1881 the "lamp works" was equipped with its own power plant, a Babcock & Wilcox boiler of 75 rated horsepower being supplied for steam generation. The "lamp works" were moved complete to Harrison, New Jersey, in May 1882, and later additional Babcock & Wilcox boilers were installed in the new plant.

The first central station for incandescent lighting established in the world was that erected at 57 Holborn Viaduct, London, in 1881 and 1882. A Babcock & Wilcox boiler of 146 horsepower supplied the steam for the Porter-Allen engine which was direct connected to the No. 2 Edison "Jumbo" generator. This unit was first started January 12, 1882, and after the addition of a second unit the Holborn Viaduct was started in practical operation on April 12th of the same year.

The Holborn Viaduct station was in reality an exhibition central station plant, primarily for the purpose of demonstrating abroad the practicability of the Edison system. Having fulfilled the purpose for which it was installed, it was dismantled about 1884.

The first central station for the commercial distribution of electricity for incandescent lighting was the historic Pearl Street station of the Edison Electric Illuminating Company of New York (now the New York Edison Company), which was placed in commercial operation September 14, 1882. In referring to this station, "Edisonia, a Brief History of the Early Edison Electric Lighting System," compiled and published under the auspices of the Committee on St. Louis Exposition of the Association of Edison Electric Illuminating Companies, says:

> "This was the station which did the remarkable work of demonstrating not only the practicability, but also the commercial success of the Edison multiple arc system—that epoch-making series of Mr. Edison's inventions from the steam dynamo to the lamp, including the dynamos, regulators, feeder and main system, underground distributing system, safety

fuses, cut-outs, switches, sockets, meters and, last but not least, the crowning achievement — the incandescent lamp."

This station contained six dynamos of the Edison "Jumbo" type, each with a capacity of 1200 "A" or 16 candle-power lamps of 110 volts, 0.75 amperes, or approximately 100 kilowatts per unit. The dynamos were originally driven by Porter-Allen engines, which were subsequently replaced by Armington & Sims engines.

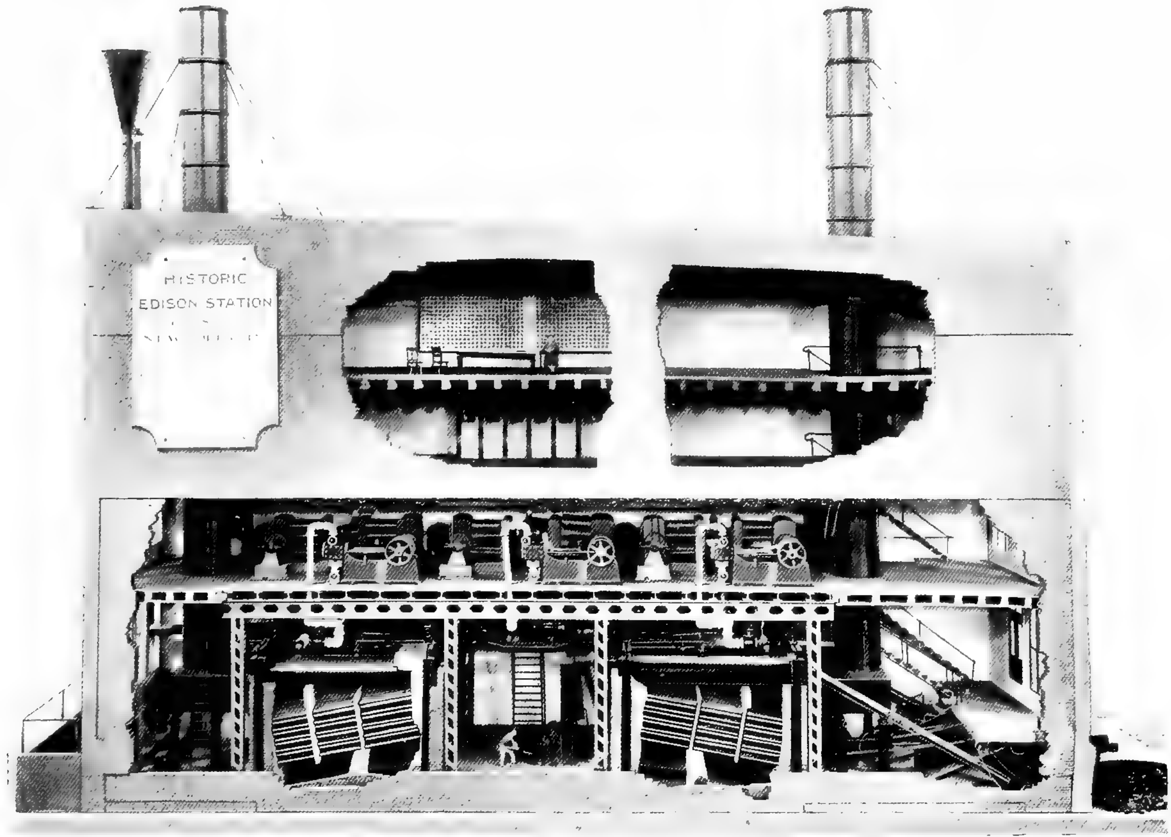


Figure 1. Photograph of the Model of the old Pearl Street Station Exhibited at the St. Louis Exposition

Steam was supplied by four Babcock & Wilcox water tube boilers, thus establishing at the very beginning of central station practice the close relation between this boiler and the electrical industry.

Each boiler consisted of 14 sections of 8 tubes 18 feet long, connected to two 36-inch drums and containing 2400 square feet of heating surface. The boilers were rated, in accordance with the practice of the day, on the basis of 11 square feet per horsepower, or 216 horsepower each. The drum heads were of cast iron, as were the headers. The boilers were built for a safe working pressure of 150 pounds and the safety valves were set at 140 pounds, a figure considerably in excess of the pressure ordinarily carried at that time. The boilers were hand fired, and it is probable that the capacities developed were little, if any, greater than their normal rating.

"Edisonia," quoted above, refers to these boilers in the following manner:

"As an evidence of the life of this class of apparatus (Babcock & Wilcox boilers), it may be of interest to note that from the time this station was put into service September 4, 1882, until March 31, 1894, they were in constant service at this station under very severe conditions; they were then removed and put into

service at the 53rd Street station, where they continued in regular service until May 22, 1902, nearly twenty years of practically continuous hard service."

An idea of the general layout and size of this, the first commercial central station, may be obtained from Fig. 1, which is reproduced from a photograph of a model exhibited in 1904 at the St. Louis Exposition.

Some idea of the truly remarkable increase in power developed in central stations may be obtained from a comparison of the Pearl Street station capacity and that of the New York Edison stations as they exist today. Against the total rated output of the Pearl Street station of 600 kilowatts, the New York Edison Company stations today have a total rated capacity of 315,000 kilowatts. Against a total rated capacity of 864 boiler horsepower for the original stations, the present New York Edison plants have a rated capacity of 123,000 boiler horsepower, and all of these boilers were manufactured by the Babcock & Wilcox Company. It is to be remembered, too, that while in the original plant ratings above normal were not sought or obtained, in the present plants ratings of 250 to 350 per cent are regularly obtained over peak load periods.

A more detailed comparison of the boiler and prime mover equipment of the first central station and a modern plant is of interest, and for such comparison the various stations of the Commonwealth Edison Company of Chicago may be taken as typical of present day practice.

The first of the units installed for the Commonwealth Edison Company, erected in 1902 and 1903, indicate the remarkable advance in power plant equipment and operation in the twenty years following the Pearl Street station. At this time the Commonwealth Edison Company installed the first 5000 kilowatt turbine erected in this country, and for this unit, which had a maximum rated output of 6000 kilowatts, eight Babcock & Wilcox boilers were supplied, each nominally rated at 500 horsepower, or a total of 4000 rated horsepower. These boilers were of wrought steel construction, built for a working pressure of 200 pounds, each boiler being made up of 18 sections of 14 tubes 18 feet long and connected to two 42-inch drums. The increase in the size of the turbine and boiler units, together with the boiler capacity furnished per unit, is shown in the following table and gives ample proof of the truly remarkable advance in central station practice:

Date	Max. Rating of Turbine—Kw.	Number of Boilers	Rated H.P. Each	Rated H.P. Total	Rated Boiler H.P. per. Kw.
1903	6,000	8	500	4000	.666
1905	12,000	8	500	4000	.333
1908	14,000	8	500	4000	.286
1910	20,000	10	568	5680	.284
1912	20,000	4	1220	4880	.244
1912	25,000	4	1220	4880	.195
1915	30,000	5	1220	6100	.203
1916	30,000	4	1351	5404	.180
1916	35,000	5	1220	6100	.174
1916	35,000	4	1351	5404	.154

An idea of the change in boiler room practice and appearance between 1882 and the present time may be seen from a comparison of Fig. 2, a portion of the boiler room of one of the Commonwealth Edison Company's plants, and the illustration of the Pearl Street station.

The first Commonwealth installation as compared with the Pearl Street boilers and successive Commonwealth installations indicate not only a tendency toward increased unit size but also the capacities expected from a given amount of boiler heating surface. In the Pearl Street station of 1882, 864 rated boiler horsepower were furnished for a total rated output of 600 kilowatts, or 1.44 rated boiler horsepower per kilowatt. In the 1903 installation at the Commonwealth Edison Company 4000 rated boiler horsepower were supplied for a 6000 kilowatt generator set, or .666 rated horsepower per kilowatt output. The two latest installations of 35,000 kilowatt sets show .174 and .154 rated boiler horsepower supplied per kilowatt output for the five 1220 and the four 1350 boiler horsepower units respectively, or, in the latter case, about one-ninth the rated boiler capacity per kilowatt output supplied for the Pearl Street station.

The 1350 horsepower Babcock & Wilcox boilers represent the highest state of development in large central station boiler units. These boilers are made up of 42 sections of 15 tubes 20 feet long and connected to a cross drum of the marine type, 60 inches in diameter. They are of wrought steel construction throughout and are built for a working pressure of 260

pounds to conform to other units in the plant. Other Babcock & Wilcox boilers of this design for 350 pounds working pressure have been built and are in successful operation. Each boiler, which is steel cased, is equipped with an integral Babcock & Wilcox superheater designed to give 200 degrees of superheat at a rate of evaporation of 110,000 pounds per hour. It is interesting to compare this steam output with that of the Pearl Street boilers, each of which delivered approximately 6500 pounds of steam per hour. Each of these boilers is fired by two Babcock & Wilcox chain grate stokers, having a total of 333 square feet of grate surface, and the capacity given above is obtained when burning a low grade of Illinois coal.

A comparison of the weight of one of these units with that of one of the Pearl Street boilers perhaps gives an idea of the difference in size. Each of the Pearl Street boilers, with its grates, exclusive of brickwork, weighed approximately 51,400 pounds. One of the latest Commonwealth Edison Company boilers, with its superheater, stokers and casing, exclusive of brickwork, weighs 524,200 pounds.

As against the capacity of the Pearl Street station, namely, 600 kilowatts and 864 boiler horsepower, the five Commonwealth plants, all located in the city of Chicago, have a total rated boiler capacity of 126,000 horsepower and a total output of 440,000 kilowatts.

Figure 2. A Section of the Modern Boiler Room in One of the Commonwealth Edison Company's Chicago Plants as Compared with the old Pearl Street Station Shown on a Preceding Page

It is true that the Commonwealth plants are among the largest central station plants in the world. The practice of the Commonwealth Edison Company, however, as to generators, prime movers and boiler equipment and operation is typical of the central station practice of the day, and the boilers manufactured by the Babcock & Wilcox Company are universally

accepted as the standard for this class of work. It is impossible to state the total capacity of these boilers producing steam for the generation of electrical energy in all branches of power plant work, but the very close relation of the boiler to the electrical industry is indicated by the fact that there are in operation today in electric railroad, light and power stations alone—that is, central stations for the sole purpose of generating current for light and power as distinguished from manufacturing plants—over 2,868,515 horsepower of boilers manufactured by the Babcock & Wilcox Company.

CHAPTER V

Electrical Engineering as a Profession

THE idea of human control of electricity seems to have existed, at least in its negative form, in the earliest days of recorded history. It does not appear that the ancients had any conception of the electric current except as it forced itself on their recognition in its most visible manifestation in the lightnings which then, as now, awed humanity. Thus circumscribed, the ancient view of it was that this, at least, was a force that was uncontrollable. The Book of Job (thought by many scholars to be the most ancient remnant of Hebrew literature) presents Jehovah as including in a summary of Job's human limitations this query:

"Can'st thou send lightnings that they may go,
And say unto thee, 'Here we are?' "

Three thousand or more years later this ancient inquiry received its first partially affirmative answer from Benjamin Franklin's experiments in 1747-50. Other answers have since come through other investigations: at first gropingly, but in more recent years with increasing confidence through the science and art of electrical engineering.

Whether we contemplate electricity from the viewpoint of the physicist, as a form of matter, or from that of the electrical engineer, as a form of energy, it is the treatment of it from the latter standpoint that has made it a rejuvenating and reconstructive force in the world's industrial and social life and activity.

The term "electrical engineer" is of very modern origin, although one now representing, more than any other professional title, the progressive aspect of modern industry. In fact, until about the middle of the eighteenth century the term "Engineer" itself was a purely military one applied to those who devised and constructed engines of war or executed works intended for military purposes. It was in 1747 that the first technical school was established as a drawing-school — the École des Ponts et Chaussee. It was reorganized into a school for the training of engineers for the Government service. The École Polytechnique, founded in 1794, primarily to fit men for the engineer and artillery corps of the French Army, set a high scientific standing for that service, but also had a marked effect upon civil practice because many of its graduates made their way into private pursuits.

In the latter half of the eighteenth century engineering of works of a non-military character began to be recognized as a distinct profession and as the age of machinery opened up those who became technically proficient in such matters began to be called "mechanical engineers," although at first merely as a specialty of individual civil engineers. The training of the civil engineer, except in the two primarily military French schools before named, was not in college or technical school. It was scarcely recognized as a separate profession, but was usually combined with that of architect in England and America. Sir Mark I. Brunel, who was trained in France (École des Ponts et Chausées) and served in the French Navy, afterward practiced as "architect and civil engineer" in New York, before going to fame and knighthood as a great engineer in England; and his famous son, I. K. Brunel, designer of the *Great Britain,* the first ocean screw steamer; the *Great Eastern,* long the larg-

est vessel in the world, and many great docks, bridges and railways, was also French educated, though English born. John Smeaton, who planned Eddystone lighthouse, was a lawyer, who studied engineering by travel and observation, and founded in 1771, after he had made his fame, the first engineers' club in the world, afterward and still known as the Institution of Civil Engineers. Of the great inventors, Newcomer, who invented the first practical steam engine, was a blacksmith; James Watt, who so improved it as to make steam attain world-wide acceptance as a motive force, was a mathematical-instrument maker; and George Stephenson was operative engineer when he constructed the locomotive which earned him the title of "father of railways." He seems to have been the first of the great engineers to be specifically known as a "mechanical engineer," and was the founder (1847) and first president of the Institution of Mechanical Engineers.

The profession of Mechanical Engineer acquired great prominence, its importance increasing with each decade of the nineteenth century, which became distinctively the Age of Machinery. Following the distinctive creation of Mechanical Engineering as a separate profession came another form, which partook of the character of both civil and mechanical engineering as applied to mines, with much specialization in mineralogy, metallurgy and in more recent years of chemistry. The profession of Mining Engineer gained recognition as a special branch. So far as technical education is concerned, it was first recognized in Germany. The first institution in that country having any of the characteristics of a modern engineering school was the School of Mines, founded at Freiburg in order to develop engineers for working the mines in the neighborhood.

The growth in importance of engineering branches has been fairly marked, or rather followed, by the institution of technical schools. In the United States the Rensselaer Polytechnic Institute was founded in 1824 by Stephen Van Renselaer as a school of theoretical and applied science, and it has been almost exclusively devoted to the training of civil engineers. The demand for scientific training in universities led to the foundation of the Sheffield Scientific School at Yale in 1847, and the Lawrence Scientific School at Harvard in 1848. The Massachusetts Institute of Technology was chartered in 1861, but because of the Civil War did not organize its first classes until 1865. The Worcester Polytechnic Institute, opened to students in 1867, made a notable departure by providing systematic instruction in workshop practice as an essential part of the course in mechanical engineering, a feature that has been copied in practically all the technical schools of collegiate grade now giving instruction in mechanical and electrical engineering in the United States. The School of Mines of Columbia College (now University) was organized in 1864, and under its general jurisdiction have been organized the several technical and engineering schools of that institution. The opening of the Stevens Institute of Technology at Hoboken, N. J., in 1871 and the Sibley College of Mechanic Arts of Cornell University in 1872 was the beginning of the rapid development of schools of technology all over the United States, the earlier ones including Purdue University, Lafayette, Ind.; Rose Polytechnic Institute, Terre Haute, Ind.; the Michigan School of Mines, Houghton, Mich.; Case School of Applied Science, Cleveland, Ohio; Armour Institute of Technology, Chicago, Ill.; besides the engineering departments of Lehigh University, Ohio State University, Washington University (St. Louis), and the Universities of Michigan, Wisconsin, Pennsylvania, California, Illinois and other States. In nearly all of these institutions special schools or departments, or at least special chairs, of electrical engineering are a prominent feature, with full recognition of the fact that Electrical Engineering constitutes a distinct profession.

Great scientists had discovered many of the principles and phenomena of electrical science long before the mechanical activities based upon them were formulated into practice. The telegraph, the electric principles of which were based upon a series of discoveries, was made practical by Morse and came into world-wide use, spanning oceans, before the other manifestations of electric energy as applied to the generation and distribution of light and power had been made practically

available, and before even the term "electrical engineer" had come into general use. It appears that in 1868 W. N. Tiddy established at 12 Prince's Street, Hanover Square, London, a "School of Telegraphy and Electrical Engineering." It seems to have been chiefly a telegraph school at first, specializing in submarine telegraphy, but by the year 1884 its courses also included "electric lighting, including the management of prime motors, arc and incandescent lamps, accumulators, etc., and instruction in the various applications of telephony that have been carried into practice."

In "Edison: His Life and Inventions" (Dyer & Martin, New York, 1910) the advertisement is reproduced in facsimile from the Telegrapher, of October 1, 1869, of Pope, Edison & Co., as "electrical engineers." This was the first "professional card," if it may be so described, ever issued in America or anywhere else, by a firm of practicing electrical engineers. The members of the firm were Thomas A. Edison and Franklin L. Pope, a distinguished inventor, writer and expert, who became president of the American Institute of Electrical Engineers in 1886. This enterprising young concern was active and prosperous, while it lasted, and before the partners drew away into distinctive orbits; but its practice would appear to have been limited to telegraphic problems and inventions.

An article on "Instruction in Electrical Engineering" in the Electrical World of October 4, 1884, says: "We are glad to see that the Stevens Institute, Cornell University and one or two other places are paying to practice the attention it requires, and from their classes many valuable accessions to the ranks of electrical engineers are now to be expected."

In a reminiscent paper read to the New York Electrical Society on November 25, 1912, the late Horatio A. Foster tells how, in October, 1884, having been connected with a railroad contractor in Eastern Pennsylvania "as paymaster, bookkeeper, and incidentally engineer," he received a copy of the Springfield (Mass.) Republican in which was a short paragraph headed "New Occupation for Young Men —Electrical Engineer." He goes on to say that this was an entirely new occupation to him, and the first time he had seen the combination "electrical engineer," but the article interested him, and he showed it to his contractor-employer with the remark that he would like to go into the profession it described. The contractor read the article and told Mr. Foster that the matter could be easily arranged, as his partner had made a large investment in the Daft Electric Motor Company and would doubtless take pleasure in introducing him to the officials of that corporation. Thus he entered the electrical profession, his first jobs being winding field magnet coils, assisting in armature winding, machine testing, assembling, etc. He said: "There were no schools at that date furnishing an electrical education. I was advised by Mr. Daft to purchase Kempe's 'Telegraph Engineer,' Gordon's 'Electricity and Magnetism,' and, much to the surprise and pleasure of everyone, found a book, Thompson's 'Elementary Lessons in Electricity,' which has continued to be, in its numerous editions, an important textbook. This, together with work in the office or in testing, and through talking with such few electrical engineers as there were at that time, comprised practically all the education that one could then acquire before going into the field."

The American Institute of Electrical Engineers was established in May, 1884, and in 1885 the society had three hundred members and associates, but at that time the profession had not become fully specialized and of its members many, if not most, were mechanical engineers who regarded electrical engineering as a branch or specialty of their main profession. This was the general view at that time, just as, a quarter century before, mechanical engineering had been looked upon as a branch of the profession of civil engineer.

About 1882 Dr. Werner Siemens spoke, at a meeting of the German Electrical Society, upon the desirability of founding, in all the technical colleges, professorships for electrical engineering. The suggestion was taken up by the technical colleges and professional schools of Germany so eagerly that Dr. Siemens, speaking before the same society a few years later, declared that his suggestion had been misunderstood as if he had advocated the establishing of professorships for the pur-

pose of educating a special class of engineers, viz., electrical engineers. It was Dr. Siemens' idea that electrical engineering was not a separate profession but a branch of that of the mechanical engineer. The instruction in German universities, at that time, seems to have been chiefly theoretical, but at Cornell, Yale, Harvard, Stevens Institute and the Massachusetts Institute of Technology the course was very practical, being the course in mechanical engineering chiefly up to the third year, with very thorough specialization in electrical subjects during the fourth year.

But from 1890 on the electrical industry expanded so rapidly that there was imperative call for men of the right training and proper caliber to undertake the putting into concrete shape and appropriate application the new ideas that were constantly widening the scope of usefulness of electricity. The need was for closer specialization, and a large number of young men, starting active careers in the last decade of the nineteenth century, made rapid progress to prominence because of specialization in a particular branch of the electrical industry. In the development of the electrical profession the value of technical training has been amply demonstrated. Electrical corporations have, not without reason, shown marked preference for electrical engineers who have graduated from a college or technical school.

Professor Francis B. Crocker, in an article in the Saturday Evening Post, June 22, 1901, tells how, having personally followed the careers of several hundred men in electricity, he had become convinced that they had gone ahead more rapidly than would have been possible in any other line of human effort. He estimated that nearly all of them make a good living within a year or two after they graduate, and achieve substantial success within three or four years. He cited instances of young men who reached prominent positions and won national reputation within five years after their graduation from Columbia University. One of these had become the chief engineer of the Niagara plant, the largest in the world; another was professor of electrical engineering in a prominent university, another had become chief engineer of a well-known manufacturing company in less than two years after graduation.

One of the reasons for the rapid advancement of electrical engineers as seen by Professor Crocker was the fact that the industry was new and had expanded enormously, forcing men ahead. Another was that electricity is a peculiar subject. Perhaps analysis of the endowment required for eminence in the profession of electrical engineering has never been better presented than in the following paragraph from Professor Crocker's article:

"In its pursuit general intelligence or knowledge is not sufficient for pronounced success. A man possessing special taste for it soon differentiates himself from the others working alongside who may not be endowed with the same advantages. Such a man will forge ahead of his fellows at a rate that is absolutely impossible in any other calling in the world. The successful engineer has more than mere ability. He is gifted with special talent, like the successful artist or musician. Electricity is, to my mind, the only mechanical pursuit that has 'soul.' The successful electrician is born. Many of the qualities that are his are intangible, just as the fine musician's are. But there must also be tangible qualities, certain fixed mental traits. He must have great mental alertness; the ability to think quickly, to grasp a given situation at once. He must be of an analytical turn of mind—that is, be able to reason from cause to effect and vice versa. In electricity one thing follows from another with absolute certainty."

It was stated as Professor Crocker's belief that the proper attitude of the electric worker is that of willingness to accept innovation, and not of prejudice against it. "It is the first duty of an electrical worker to fall in with rapid advances and radical departures. Therefore a necessary qualification for the successful electrician is an interest in things that are new *because they are new*. Any one with a strong conservative tendency would be at a disadvantage in the electrical field. This is probably the reason why Americans have got along faster than any other nation in the development and use of electricity. An American prefers a thing that is new, whereas a foreigner considers newness in itself an objection. The man who is interested in

ancient literature or in archæology cares little for electricity. That is a fact I have observed among my own friends."

With the progress of the years, electrical engineering has reached a point where it does not have to argue about its professional standing. In consequence of its many new phases it now represents countless activities which, first welcomed as conveniences, have so favorably impressed themselves in their reactions upon life and industry as to entitle them to be considered as necessities of our broadened civilization. As a matter of fact the electrical engineer has advanced to a position that is paramount among the various branches of modern engineering. The latest edition of the Encyclopedia Britannica, after discussing the several subdivisions of the engineering professions, enumerating military, civil, mechanical, naval, sanitary, gas and chemical engineering, says: "The last great new branch is *electrical* engineering, which touches on the older branches at so many points that it has been said that all engineers must be electricians."

Yet the profession is still a young one, and some of those who are rated as veterans in it are scarcely middle-aged. Among the most prominent are men whose courses of preliminary training showed great diversity. Among them are not a few who, having begun their business life in other vocations, afterward entered the electrical field because of the sudden growth of electrical business and attractive opportunities offered by it, while others have come into it by the regular course of training in college or professional school, followed by experience in shop and field. It used to be a matter of argument as to whether the so-called "practical" man, who graduated from the machine shop, or the graduate of university or professional school was the better prepared. In the past, especially in the period from 1885 onward, some of the most successful electrical engineers were indisputably of the class of practical men with little or no theoretical training. The conditions have very greatly changed since the days they became prominent. In the early days of the electrical profession there was comparatively little of settled theory or predetermined data of results. Such data as were used were mere approximations and much of the work was mere guesswork. But in the progress of electrical science such development in exactness has been attained that no excuse remains for rule-of-thumb methods, and exact theory enters into all work. Where an art is in a stationary condition a practical man may by long familiarity become so familiar with its apparatus and processes as to be qualified for engineering practice. But in electrical engineering the rapidity of growth of the art surpasses all precedent. New discoveries cause changes and elaboration of electrical theory which lead to constant change, modification and improvement in the design, construction and operation of electrical machinery.

Under these circumstances of constant revision and expansion the man whose knowledge is based only upon his practical experience is at a disadvantage. Many men who in the earlier years of the profession attained prominence in it have found themselves wholly unable to keep up with its rapid progress. Not that all those whose entry upon the profession was without theoretical training have been left behind. Professor John Perry, F.R.S., former president of the Institution of Electrical Engineers of Great Britain, speaking upon this identical subject, referred to a very important class of engineers when he said, in his inaugural address:

"Some of the best engineers I know are so exceptional that one must class them as geniuses. They have faculty and character, and so they have become engineers even under the most unfavorable circumstances. They have passed through ordinary schools, and yet have developed common sense. They were pitchforked into practical work, and their liking for the work, as well as some curious kind of instinct, led them to pick up all sorts of knowledge which has become part of their mental machinery. They continue to pick up new kinds of knowledge when these become necessary for their professional work.

"Unfortunately these men do not realize how exceptional they are, and they advise boys to go direct from schools into works. They forget that the other 99 per cent of men treated in the same way as themselves can only become the hewers of

wood and drawers of water to real engineers. Treated in this way, average boys are just like so many sheep; they learn just what seems absolutely necessary and no more; their acquaintance with the scientific principles underlying their trade is a hand-to-mouth knowledge which becomes useless when their trade undergoes development. Such men are soon left behind."

There are among the men who entered the electrical engineering profession from the practical work in shops some who not only rank evenly with their college-bred confrères as professional engineers with reference to their practice, but who are also as familiar as any of them with the underlying electrical science. But their road to that goal has been much harder than that of the man who has gone through the regular courses of technical instruction and has taken up the practical work after graduation. The mind trained to scientific reasoning and theoretical study finds it more easy to adapt its mental processes to the changes that come from new discovery and deeper knowledge than does one who has never had the benefit of such training. With the great advance in the science itself the course of study required for adequate preparation has taken on a wider range. Electrical engineering is now the most scientific of all engineering professions. The successful electrical engineer must have a special training in mathematics, physics, chemistry and mechanics, as well as a complete course of studies in theoretical electricity and magnetism, and in thermodynamics. Daily practical work with machinery operating by the principles covered by and illustrating the phenomena incident to the theory he is studying will impress it upon his mind much more firmly than the definitions of the text-book. One of the most important factors in the making of the American electrical engineer has been the plan of following up his graduation with an apprentice course in one of the large electrical manufacturing establishments, where the young engineer's knowledge is rounded out by opportunity to operate and study larger machines and a greater diversity of them than can possibly be available at any of the colleges, besides experience in the designing departments where plans and details are made for every kind of electrical apparatus.

It has often been noted in relation to college courses of every kind that the graduate is likely to look upon his sheepskin as a certificate that he knows all there is to be known of the subjects covered in his course. This is, of course, a very erroneous view on the part of every young graduate who entertains it, but especially so in the case of the newly diploma-invested electrical engineer, and the entry upon the apprentice course is especially valuable as a means to set him right on that subject. It is almost the unanimous opinion of those who have written upon this subject that the work of the apprentice course, while it may mean a smaller income for the graduate for the year after his graduation, means in almost every case a much higher position at the end of five years, and greater emoluments. The year or so in the drafting room, testing department and shops will also often give a lead to the young engineer as to the specialty he would like to follow.

If he is to become one of the greater and more successful engineers he will specialize. For the range open to the work of electrical engineers is wider than that of any other mechanical profession. He may not hope for a practice to cover it all. It is the spirit of specialization that has brought to pass the many and great developments of electrical science. It is the specialist who is putting an electrical impress on all kinds of activities and operations. Edison and some of the other immortals of the profession have covered a diversified range, but those so distinguished were all pioneer workers who wrought in new fields that were practically virgin, and whose researches led them to basic facts and original inventions in large variety. Now the progressive engineer, ambitious for mastery, does not go so far afield, but is fortified by the most wonderful accumulation of workable data to guide his way to new discovery. He usually confines his professional endeavors within some well-defined limits, for it is the specialist who comes to the front in the electrical industry. But, specialize as he may, no electrical engineer can keep up with the march of progress in electrical engineering unless he continues, by constant study, to add to

his store of education a scientific knowledge of new principles and applications in the electrical field. No electrical engineer may boast that his technical education is complete. Each year adds to the store of vital truths and novel demonstrations in electrical science. Each year new industries find that their manufacturing equipment may be improved or processes reformed by electrical equipment. Electricity is the world's energy-of-all-work, the ubiquitous Mercury transporting speech or written word instantaneously in all directions; distributor of light with profuse bounty in darkened areas; picking up the power of the cataract and delivering it, in quantities as ordered, to turn the wheels of transportation and of industry; running, lighting and warming trains and ships; welding metals together with a strength and firmness unapproached by any other means; aiding the metallurgist by extracting metals from their ores and by electro-chemical separation from their alloys, isolation of aluminum from corundum, and by processes of deposition of the finer metals upon the surfaces of baser metals (electroplating and electrotyping); aiding chemistry in the manufacture of various chemical products employed in the arts, such as alkalis and chlorine from common salt, chlorate of potash by electrolysis, calcium chloride, carborundum, phosphorous by electrolysis, artificial graphite from coal, processes for the tanning of hides, the ageing of wines, the economical production of oxygen and many more, coming under the head of electro-chemistry; purifying milk by the process of pasteurization, water by the action of actinic rays generated and distributed through mercury vapor, the neutralization of sewage and many other good offices exerted in behalf of hygiene and sanitation; enlarging the equipment and increasing the horrors of war by its terrible military efficiency; acting as more efficient substitute for sunlight in the processes of photography and blue-printing; working in horticulture and floriculture in many ways, including electric stimulus to the soil which makes plants grow larger, better and earlier; doing farm work by motors that drive corn hoists, portable elevators for hoisting and piling bales of hay, fodder, etc., ensilage cutters, threshers; apparatus to heat the incubators, light the house and barn, milk the cows, run the churn, work the pumps for house and farm, run farm and greenhouse sprinkling systems, lighten household labor by furnishing power for washer and dryer, heat for the ironer, power for sewing machine, ice-cream freezer, fans, and all the various modern machines for domestic use; furnishes light, heat and power, for homes, offices, warehouses, elevators, automobiles, fans and innumerable other activities, including motors for operating machines in every industry; in medicine, a series of electric applications which make electro-therapeutics the foremost modern triumph of medical achievement.

The things that electricity does are only dimly mirrored in this enumeration, and the manufacture of the machines and apparatus, the operation of the processes, the installation of electrically equipped plants, the design, operation and management of central stations for the generation and distribution of the electric current; all of this and more is included in the scope of electrical engineering. It also presents in an emphatic way the startling advance wrought by electricity in a few decades. By way of contrast, let us again quote from the statements of Professor John Perry, F.R.S., who, in his inaugural address to the British Institution of Electrical Engineers in November, 1900, told how in 1867, when he was an apprentice, he was "chaffed in drawing-office and pattern-shop for studying such a non-paying, non-practical subject as electricity." He further stated that when he published his first electrical paper in 1874 before the Royal Society, and even some years after, "the real students of electricity could be counted on one's fingers' ends."

This is doubtless a fair summary of conditions in England, and, while a slightly earlier start was made in the United States, the contrast of fifty years is fully as great because of the fact that this country has advanced even more than any others by reason of its larger participation in electrical discovery and invention and the readier acceptance of electrical equipment by the industries and people of the United States.

Under each of the heads of present electrical use it would be possible to tell a

graphic story of accomplishment by scientists and engineers. Much of it appears in other chapters in this book and in individual mention of the achievements of some of the leaders in these electrical activities, which have, however, been mentioned here chiefly to point to the opportunity and the need for even greater specialization. Not one of the numerous branches, enumerated or otherwise, of electrical practice has reached the stage of completion. There is no electrical engineer in any branch of the profession, however great and effective its present condition, who would claim for it the prestige of a perfected art, nor even one in which new discoveries and wider applications may not be and are not expected.

Another feature in the electrical engineering profession is the fact that manufacturing distribution and even the planning and completion of electrical installations are, to a large extent, organized in strong corporate enterprises. This is necessarily so because the interests involved are colossal, diversified but closely interrelated, and depend for their highest success upon their operation under a unified policy as interdependent parts of a harmonious whole. In these great organizations there are numerous technical and manufacturing departments, each under the direction of superintendents chosen for their expert knowledge, plus certain qualities which are requisite for success in other professions as well as this for men charged with large managerial responsibilities. They include executive ability, business knowledge, an alert mind, resourceful in sudden emergencies, ability to handle men. Above these department heads are the general executive officers who, with the directors, formulate the policies of the corporation. In many industries these might be capitalists and hard-headed business men who might know little, if anything, of the technical or practical end of the business. But the electrical business is developed to such a degree of exactness, and the value of electrical apparatus and machinery so strongly depends upon absolute accuracy, that it is usually the case that the general as well as department executives of the electrical industries are for the greater part chosen from men who have had an appropriate technical training.

Electrical engineering may be said to have begun with the invention of Gramme's dynamo in 1870. Investigation of electrical phenomena had been carried on extensively by scientific observers from the beginning of the Seventeenth Century, but mechanical applications, except those connected with telegraphy, and certain applications of the galvanic battery, did not make any general appearance until the last half, and not to any important extent until the last quarter, of the Nineteenth Century. The principle of electro-magnetic induction discovered independently by Michael Faraday in England and Joseph Henry in America in the period 1829-1831 led to the evolution of dynamo-electrical machinery and the whole range of electric machines and applications, the construction and development of which brought into play the energies and abilities of men who, having prepared themselves, have introduced an entirely new body of experts who have evolved service of the highest value and utility for the benefit of the world. Gramme's invention was slow in making an impression on this side of the ocean. There were only two electric light exhibits at the Centennial Exhibition at Philadelphia in 1876. But with the invention of the Brush arc system of lighting introduced by Charles F. Brush in 1879, the development of the Thomson-Houston system about the same time, and the Edison incandescent system soon following, a vocation was made for engineers to supply a demand that has increased progressively from that time to the present.

Improvement in dynamo-electrical machinery also went on apace, and the development of alternating current machinery and installations greatly enlarged the use of the electric light. The use of transmitted electric power increased as it became evident that it was more economical, more dependable and more controllable than any other. Electrical engineers began to be trained in technical schools and came out with a better preliminary equipment for the profession than many of those pioneer engineers who, with far less educational advantages, had been prominent aids and many of them among the leaders in the foundation of the electrical indus-

try. Many minds were working on the problems of electricity, or rather the practical problems of electrical applications, where only a few had been working before. At first the industrial application of the electric motor was practically a mere substitution for the steam engine. It had its advantages, especially where the enterprise was large enough to support an isolated plant, but not enough, in the view of many owners of mills and factories, to induce them to undertake the initial expense of reorganizing the entire plant. But as, in the improvement of dynamo-electric machinery by the introduction of the individual motor drive, electrical engineers worked out not only a much more efficient but also a more economical way of conducting industries, the motor-driven plant became more popular, and is now the standard of industrial efficiency. Perhaps this evolution may be best described by an illustration contained in an address by Mr. Samuel Insull at Camp Coöperation in 1913:

"A mere substitution may increase efficiency, may be an advantage, but if the mere substitution of the electric motor increased economy, then the reorganization of that industry to adapt its operation to the maximum economic efficiency of the electric motor would naturally be still more economical. I have seen this development in the organization of the cotton industry, from the steam engine to the electric motor. There a prominent electrical engineer had made it his life work to study the problem and to solve it. I refer to Mr. S. B. Paine, the pioneer in electrical operation of cotton mills. I remember in 1894 when the first electrical power transmission in the cotton mills of the South was introduced. The steam engine, driving the old mill, was replaced by one big synchronous motor, driving the same mass of shafting and countershafting and belting that was driven before. A new mill on the same system that was being opened did not have the big amount of shafting and belting, but had hundred horse-power induction motors, each driving a single line of shafting. Now even that has gone, and individual motors drive individual machinery and so realize the maximum economic efficiency of the electric power. You see, with steam that is impossible. You could not have a steam engine or a gas engine for every loom, but you can have an electric motor. And so, you see, the mill industry has moved from the New England States, and the steam engine, driving shafting and belting, to the Southern States, near the source of supply, the field of abundant cheap water power, to the individual motor drive. Here we have, in the relatively short time of twenty years, seen the reorganization of an industry which is more complex than many other industries, a rearrangement or reorganization to suit a different kind of power."

The work done by this engineer in the textile field is typical of that accomplished by other electrical engineers, each according to his abilities and opportunities, in other avenues of human endeavor. Mr. Insull in the quoted paragraph shows the transforming effect of the electrical engineer's work in the cotton industry, but the same effect of transformation, some in less but some in even greater degree, is visible in the work of the electrical engineer in connection with most of the other industries.

Electric lighting progressed under the inventive genius of Edison, Brush, Elihu Thomson, Weston, Wood, Hochhausen, and in the new era Nikola Tesla, Stanley, Bradley, Steinmetz, Hewitt and others, but besides these hundreds or thousands of electrical engineers have helped from the results of their informing experience or inventive genius to bring to high efficiency the lighting service of civilized places large enough to support or near enough to become auxiliary to a central plant. But the work of expansion still goes on. Even country roads in the better settled sections are electric lighted, and yet, great as the improvement in lighting is, there is still quantitative work for the illuminating engineer, in view of the fact that even in the United States, which uses electricity in larger measure than any other country, only about thirty per cent of the population has the benefit of electric light service. Even as to the quality of light and methods of distribution the possibilities of improvement have not been closed, and the field of opportunity in the lighting section of the electrical engineering is still a wide one.

But the stimulus given to electrical engineering in the last quarter of the Nineteenth Century was not circumscribed by concentration upon electric lighting and factory power. As improvements made dynamo-electric machinery more practical it became evident that applications to railway operation would offer one of the most valuable fields of its usefulness. Experiments on electric railways antedated the dynamo, and several successful experiments in electric propulsion had been made —successful in the sense that electric locomotives had been built which moved along railroad tracks by energy derived from chemical batteries. But the expense of that mode of generation made their use in actual railway service prohibitive, and the commercially practical electric railway did not appear until after the invention of the dynamo. Improvements to adapt this invention were sought by numerous inventors, and the first demonstration of a working electric railway of full size was made at the Berlin International Exposition by Siemens and Halske. It was an exhibition line, 1,000 feet long, and propulsion was effected by a dynamo constructed by Werner Siemens, connected by double reduction gearing to the axle of a car capable of carrying twenty passengers. Thomas A. Edison and Stephen D. Field, in America, began their experiments in 1880, but a contention between them over the priority of patents delayed real results until 1883, when the interests of the two were consolidated and an exhibition line 1,500 feet in length was installed at the Exhibition of Railway Appliances at Chicago, where an electric locomotive was run, taking current from a third rail, with joints bonded to improve its conductivity. Later in the same year an overhead experimental line was exhibited in Chicago by C. J. Van Depoele, the inventor of the trolley system, which, with great rapidity, passed into extended use all over this and other countries, and after the patents were sold to the Thomson-Houston Electric Company was, with the larger resources of that company and its successor the General Electric Company, developed into one of the most important departments of electrical industry. About the same time that Mr. Van Depoele was introducing the trolley system, Leo Daft was building a third rail line from Saratoga Springs to Mount McGregor, N. Y.; and E. H. Bentley and Walter Knight built a conduit line in Cleveland, Ohio, and later one in New York and one in Boston. But electric traction received its most remarkable impetus from the contract made by the Union Passenger Railway Company, of Richmond, Virginia, with Frank J. Sprague to equip its thirteen-mile system of street railways for electric traction. Capitalists as well as inventive electrical engineers became interested in electric railroad problems and electric railways underwent rapid expansion and improvement until today all other methods of railway traction for intra-urban and interurban passenger transportation have been eliminated in favor of electrical methods. As these lines and systems increase in number and mileage the field of opportunity for the electrical engineer correspondingly enlarges. It is not only in convenience to the traveling public and the emolument of owners and workers on the electric lines themselves that the transformation wrought by electric railways can be gauged. Dr. Charles P. Steinmetz has justly characterized the larger social and industrial value of the trolley system in an address from which we quote as follows:

"We are not impressed when we see the every-day trolley car passing by us; we do not realize, because familiarity breeds contempt, that this insignificant trolley car is really bringing about, and has brought about, a social revolution in modern life difficult to realize, a revolution which the dweller in the big city does not realize, but which you realize when you look over the country and its industries. What the electric railway does and has done is to take away the population from the cities and bring them back again to the country. The problem which our Socialists have been helpless to solve, the crowding of the people into the cities and the depopulation of the country, with the resulting deterioration of the nation, is solving itself before our eyes by the work of the trolley car, which brings the city dweller back to the country, by making the country available for his residence and which makes the superior working conditions of the city available without leaving the country.

The trolley car has taken the industries away from the crowded cities to the country town. Industrial cities, like Schenectady, could not exist without the trolley lines. It would not be possible to have an industry, employing 20,000 skilled men, exist in a country town without the electric railway as a means of quick and cheap transportation, so that the population can cover a sufficient territory to get decent living conditions. Without the trolley car it would mean to supply the employees of the factory from a population crowded together in a small territory, within walking distance, in crowded tenements, with the resultant degeneration and deterioration of the conditions of living, and with the resultant change in the character of the working population. Instead of a law-abiding American city we would have an industrial town of the character that has become notorious in the past few years by outbreaks which might almost be called local civil war. This improvement, from a factory town to an industrial city, the trolley car is bringing about."

Heavy railway work is still chiefly accomplished under steam. Steam railways have not yet been electrified, with the exception of a few cases where special conditions existed, such as tunnel operation, mountain railways, and terminal work chiefly in cuts and subways of the greater cities. But in the aggregate the electric railways of the country have grown to such large importance that they consume a larger total amount of power than the aggregate of all the steam power used by the steam railroads. Such is the vastness of the great railway industry built up by the electrical engineers of the country within the compass of three decades.

Another field in which the skill of the electrical engineer has worked wonders, or rather two fields which may be grouped together because of the similar way in which electricity has been applied to them, is in its results in chemistry and metallurgy. Here is a group which has been chiefly remarkable for what has resulted from the superior capacity of electricity for the concentration of energy. Many of these results could never have been accomplished through any other than electric agency. It is possible to separate iron from its ore by means of the chemical energy of fuel (coal) aided by the hot-air blast in the blast furnace. But this is not sufficient energy to separate aluminum from its ore, for which we must depend upon the higher concentration of electric energy. So that to the advance of electric science and the skill of the electrical engineer we owe the fact that aluminum is practically available, and in like measure we are indebted to the same source for the commercial availability of calcium carbide, silicon, chromium, cyanide and nitrate fertilizers, ozone and other products made practically available only by electric energy. To the electric furnace, with its concentration of energy, we also owe the discovery and popular use of carborundum and of artificial graphite of a purity unknown in natural graphites. Other products of importance formerly only obtained by roundabout and expensive chemical methods are now procured by the energy concentration of electricity, including caustic alkali, chlorides, phosphorous and others. So also copper refining, iron smelting and other metallic reductions and processes which can be accomplished by fuel energy and other means can be effected more economically and with fewer disturbing factors, a truth which is impressing itself on the metal industries so that electro-metallurgy is one of the most promising fields for further efforts.

More and more the advance of electrical applications are being aided by constant improvement in and enlargement of the means and instrumentalities of electrical transmission. The earliest of the important commercial applications of electricity—the electric telegraph—owed its success to the transmissibility of electric energy, but in their earlier manifestations all of the electrical industries were more or less localized because of the supposed limitations of transmissive power. The telegraph lines were at first short, and longer distances were covered by relays, but the time came when distance no longer presented serious obstacles. The telephone was in local use only for several years, and it is only a comparatively recent event that it has been possible to converse over wires across a continent. So light and power have increased in transmissibility with the advance of electrical engineering, and the harnessing of Niagara, with

the results there obtained, was only a beginning of the wonder-working accomplished by the profession, which still finds in the constantly increasing solutions of transmission problems one of the most fruitful fields of engineering endeavor.

With achievement the profession of electrical engineering has been constantly acquiring greater importance, greater dignity and greater responsibility. It is a profession which calls for the highest intellectual qualities in its practitioners, or at least such of them as are to contribute to the ever-expanding triumphs of electrical science. The vastness of accomplishment already achieved by the profession seems almost like magic or wizardry to the layman, but no one can see more clearly than the engineer himself that the field of progressive endeavor in the discovery of new phenomena in, and the making of new applications of, electricity is practically limitless. Each engineer is constantly confronted with problems that apply to the particular part of the field in which he operates.

Few, indeed, are the large industries in which electrical equipment is not an important factor. An electrical engineer is now an important auxiliary in many industries which not long ago seemed entirely apart from electrical problems. The colliery, the quarry, the mine, large factories of all kinds, transportation systems, ships, docks, all need his services. He is a most important part of armies, navies and air services in the equipment and conducting of war. He is a necessary and responsible adviser and official in connection with many of the important problems of our larger cities. He is the minister of social comfort to the common life, and creator of more efficient and better working systems in nearly all industries. He is bringing the nations closer together and conferring upon the more backward ones many of the means of advance to a higher civilization.

The number of electrical engineers has increased and will increase in response to the law of supply and demand, but as the science of electrical engineering advances it adds constantly to the volume of knowledge prerequisite to success in its practice, and this fact will tend to keep the profession from overcrowding. As the most scientific of the mechanical professions, the number of those who enter it will be curbed, so that incompetence will not be likely to endure, or at least survive, the tests of practice. The means of acquiring technical preparation have, of course, greatly increased. It is not much more than a third of a century, if that long, that the first student was specifically graduated as an electrical engineer. A half century ago the scholastic instruction in electrical engineering was practically confined to a few lectures from the chair of physics, and from that position it has advanced to the position of a separate department in many of the universities, having its own dean, with its complete and elaborate teaching and shop equipment. The growth of the educational advantages for the engineer has indeed been wonderful. In 1885 one could count on his fingers the institutions in the United States giving engineering instruction, but twenty-five years later, in 1910, there were one hundred and twenty-nine universities, colleges and schools of technology giving professional instruction in engineering, and of all the branches that in electrical engineering was the one upon which the greatest interest centered.

This is true not only educationally but practically. There is no profession which enlists the interests of its practitioners more fully or attracts more complete loyalty. None is better organized for progress. The electrical societies, the organizations maintained by the great electrical companies for post-graduate instruction, the ties of a common pursuit in which new laurels are always to be won make of the profession of electrical engineering one which honors its members individually and as a body. They have wrought and are achieving wonderful things.

CHAPTER VI

STORY OF THE EARLY ELECTRIC RAILWAY

THE electric railway, which for urban and interurban service has superseded all other forms of traction, comprises within itself one of the most important applications of electricity. It is the modern development of an industry inaugurated by the horse-drawn passenger coach, expanded by the cable railway, extended by the overhead trolley and brought down to the last word in refinement of operation by the underground subway third-rail system of today, which, for high speeds, efficiency and safety, stands alone among methods of transportation.

About 1828 the "John Mason," a vehicle resembling an omnibus, was pulled by a team of horses over strap iron rails laid on stone ties in Fourth Avenue, New York City. This was the first street railway for passenger service. About twenty years afterward another line was built in Sixth Avenue, New York City, which was sufficiently successful to encourage its promoters to further efforts. Perhaps half a dozen other roads were constructed between 1850 and 1855, and such progress was made that, at the taking of the census in 1890, there were in operation in the principal cities of the United States 769 street railways.

The cable system, which has become practically obsolete in this country, enjoyed about twenty-five years of popularity following its introduction in August, 1873. Its installation was due to the pioneer work in San Francisco of Andrew S. Hallidie and his associates, Asa E. Hovey, William Eppelsheimer and Henry Root, although the basic idea had been suggested some years previously by E. S. Gardiner, of Philadelphia. This system consisted of a steel cable travelling in an underground slot through which it was pulled by heavy machinery placed at a central power house. Each car was provided with a grip by which it could be attached and detached from the cable. Over a thousand patents were issued on cable railways and their detailed apparatus up to 1890, since when the superiority of electric traction has shown them to be obsolete. A great deal of ingenuity and fine engineering talent was displayed in the designing, construction and operation of cable railways, and many of our most prominent electric railway men secured their early training in this field. As a matter of fact, the success of street railways operated on the cable system was one of the reasons why capitalists and street railway men gave encouragement to the early trials of electric traction.

The long delay in the introduction of the electric railway for passenger traffic was due primarily to the lack of a source of cheap current supply. It was not until the commercial perfection and introduction of the dynamo that the principles of the electric railway, which had been demonstrated almost fifty years before, could be put into practice. All the original experimenters in the electric railway field had been obliged to demonstrate their ideas with current obtained from primary batteries which, of course, precluded any possibility of commercial success because of expense. This was true of the pioneer, Thomas Davenport, who, in 1835, operated a small, circular electric railway at Springfield, Mass., which was driven by batteries carried on the vehicle. Davenport also was granted a

patent which defined electro-magnetic power as a governing principle. Prof. Moses G. Farmer, the distinguished American inventor, built and exhibited in 1847 a passenger-carrying electric locomotive which ran on a track with a gauge of eighteen inches. His power was obtained from 48 Grove batteries carried on the locomotive. Thomas Hall, in 1850, at the Mechanics Fair in Boston, exhibited on a track 40 feet long a small electric locomotive driven by two cells of battery and hauling a trailer car. About this time Dr. Colton, a well-known New York dentist, assisted by a man named Lilly, demonstrated a working model of an electric locomotive, the most interesting feature of which was the use of the track rails as a part of the return circuit for the operating current. Probably the most serious attempts at commercial electric traction were those made during this period by Prof. C. G. Page, of the Smithsonian Institution, at Washington, D. C., who had developed a reciprocating electric motor resembling in appearance the steam engines of the day.

Prof. Page, after constructing one of his reciprocating motors which developed over sixteen horse-power when driven by 100 cells of Grove battery, made an experimental trip over the tracks of the Washington & Baltimore Railroad on April 29, 1857. Starting from Washington, the trip to Bladensburg, a little over five miles away, was made in thirty-nine minutes and a maximum speed of nineteen miles an hour was developed. The round trip was covered in one hour and fifty-eight minutes. The batteries were jolted out of connection by the rough track and great trouble was experienced in keeping them at work. Although this experiment must have been very costly, Prof. Page was not discouraged, but for some years continued his work on electric motors, all of which involved the reciprocating principle.

Henry Pinkus was an early pioneer who proposed and provisionally patented in 1840 the idea for an electric railway which should feed the motors current through the track rails. The Patent Office has had to refer many modern inventors to his work.

A sharp revival in electric railway experiments followed immediately upon the production of the commercially successful dynamo-electric machine. Inventors both in Europe and the United States began at once their efforts to produce practically operating systems using the dynamo as a source of current supply. Dr. Werner Siemens made some noteworthy experiments at Berlin in 1867 and in 1877 the work of Siemens and Halske attracted attention. In 1879 Stephen D. Field, a member of the distinguished American family of that name, evolved elaborate plans for an electric railway which he soon after built at Stockbridge, Mass. It was about this time that much consideration was given to the methods of getting the current from the dynamo to the motor on the electric locomotive. The idea was conceived of using a third rail, sometimes between the track rails and sometimes laid on short posts to one side, for the outgoing current which was passed through the motor and returned through the track rails. Thus the beginnings of the third rail system were made in the crudest possible manner but with success. This was the incubating period of the great electric traction industry, for inventors all over the country began to glimpse the future possibilities and to prepare for their development.

At Menlo Park, N. J., from 1880 to 1882, Thomas A. Edison made a great many experiments in electric railway work, built a number of motors and locomotives and hauled over his private track a great deal of freight and many thousand passengers. Henry Villard was so impressed with the work Edison was doing that he entered into a contract with him under which he was to build at Menlo Park two and a half miles of electric railway, three cars, one passenger locomotive with a speed of sixty miles an hour and a freight locomotive with a capacity for hauling ten net tons of freight at a power cost per ton mile less than that of the steam locomotive. Mr. Villard agreed to pay the actual expenses of this experiment, if it was successful, and agreed further to negotiate for the equipment of fifty miles of electric railway to be installed in one of the western states. Mr. Edison has since stated that Mr. Villard advanced about $40,000 on account of this contract which undoubtedly would have been carried further had not the Northern Pacific

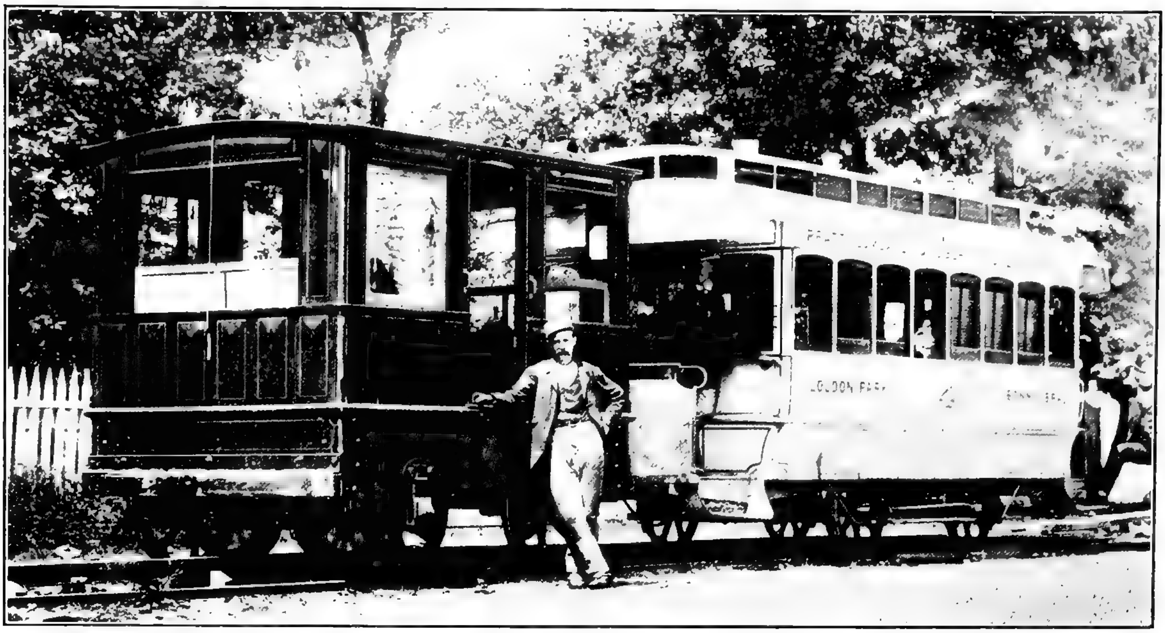
Railroad, in which Villard was heavily interested, gone into the hands of a receiver about that time.

The early Edison locomotives resembled in their outward appearance the steam locomotives of the day, having a cab, cowcatcher and headlight. Friction pullies were used to transmit the power from the motors to the axle, but as they did not prove successful, they were abandoned in favor of belts. At starting, the belts slipped a great deal. This led to use of resistance boxes which were located on the locomotive and connected in series with the armature of the motor. Three boxes were used and the motor was started with all of them in circuit. When normal speed had been obtained the driver, by means of plugs or switches, could throw the various boxes out of the circuit and thus by degrees increase the speed. A number of other experiments followed in quick succession until they were brought to a close in 1882. During all this work the operating current was transmitted to the motor through the track rails and was supplied through underground cables from the dynamo plant of the Edison laboratory. Copper bonds also were used at the rail joints to increase the conductivity. In the early part of 1883 the electric railway patents, devices and interests of Edison and Field were merged into The Electric Railway Company of America, when Edison, at least for the time being, abandoned the railway field.

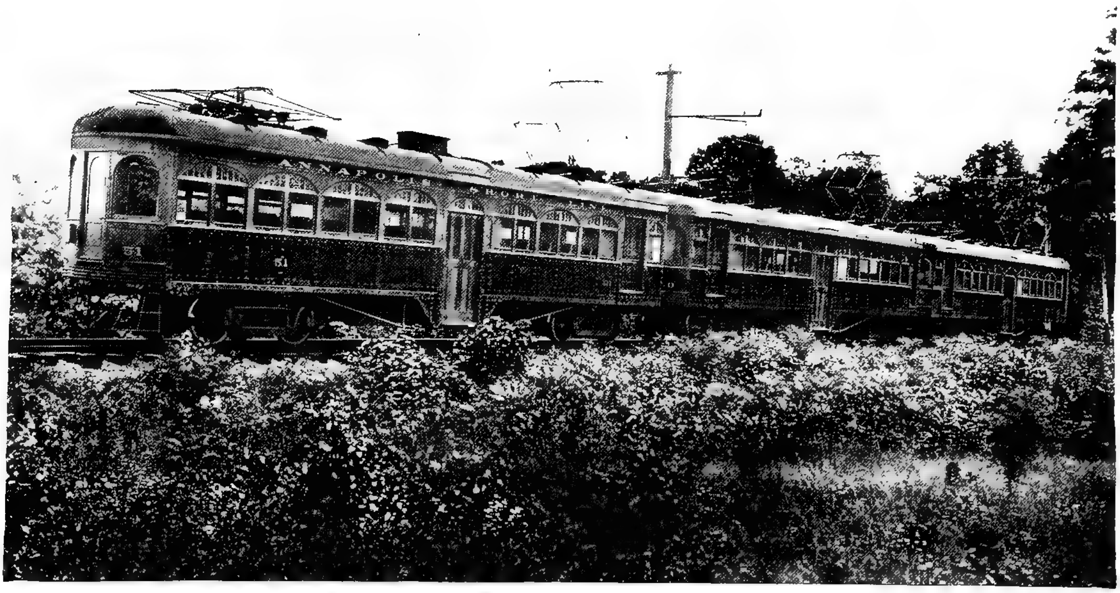
At the Chicago Railway Exposition of 1883 an electric railway was built and operated by S. D. Field, C. O. Mailloux and Frank B. Rae which was constructed on the third rail design. The track ran along the gallery of the main building, was about a third of a mile long and three feet gauge. The locomotive was named "The Judge," after Chief Justice Field, of the United States Supreme Court, who was an uncle of Stephen D. Field. One car was hauled by the locomotive, and during the month of June over 26,000 passengers were carried. At the Louisville, Ky., Exposition in the fall of 1883 "The Judge" was again exhibited to admiring thousands. In this locomotive, as in Edison's, the motor was placed on the floor of the car and not beneath it. Power was transmitted by bevel gears and a countershaft with two pulleys. An average speed of eight miles an hour was made with a maximum of twelve miles. Several original devices, including a rheostat for controlling the current, were used. A cleverly designed contact brush composed of phosphor bronze wires was used to pick up the current from the third rail. "The Judge" was twelve feet long, five feet wide and weighed about three tons.

Leo Daft, an Englishman, who was one of the very first to make a commercial business of manufacturing and operating electric motors from a central electric station in New York, was also among the early workers in the electric railway field in the eighties. He built and placed in operation at his company's plant at Greenville, N. J., a successful locomotive. As a result of this, the Saratoga & Mount McGregor Railroad was electrically equipped in November, 1883. This line was twelve miles long, with many sharp curves and steep grades. The "Ampere," as Daft's locomotive had been named, hauled a passenger car successfully over the road. In this instance, also, the motor was mounted above the floor of the locomotive. The current was picked up from a central rail by phosphor bronze contact wheels with spring mountings to insure flexibility. In 1884 Daft built a small road on one of the long piers at Coney Island, the seashore resort near New York, which carried in one season over 38,000 passengers. Another Daft road was installed a little later at the Mechanics Fair in Boston which hauled four or five thousand passengers a week for a month. This locomotive, which had been named the "Volta," was shortly afterward taken to the New Orleans Exposition and run on a line about a fifth of a mile long connecting the main building with the United States Government Building.

The Baltimore Union Passenger Railway Company owned a line extending out through the villages of Hampden, Mt. Vernon and Woodberry, a distance of perhaps two miles, and reaching an altitude of about 150 feet above the city of Baltimore. In 1885 Daft was called upon to equip this line electrically, and he built two new locomotives in which the motors were placed as low as possible on the floors. The motion of the armature shaft was transmitted to the wheels through internal



View of the Daft Dummy Motor Car as it Appeared in 1886



A Train on the Annapolis Short Line of the Maryland Electric Railway Equipped in 1908, Thirty-two Years after the Above, Showing the Rapid Advance Made in the Electric Railway Development

gears. A third rail for the supply of current was laid between the track rails and the latter were used as the return circuit. A part of the line was equipped with an overhead trolley wire. This section of road continued in operation until it became a part of a network of electric railways equipped with modern apparatus. About this time Daft electrified several other street railways in different parts of the country. He generally used two overhead trolley wires with two contacts. This did away with the third rail and also the necessity for using the track rails as part of the return circuit. During this period he also was making a series of experiments on the New York elevated railways. For many years following the installation by Daft of the double overhead trolley it was widely used and on a number of important street railway systems.

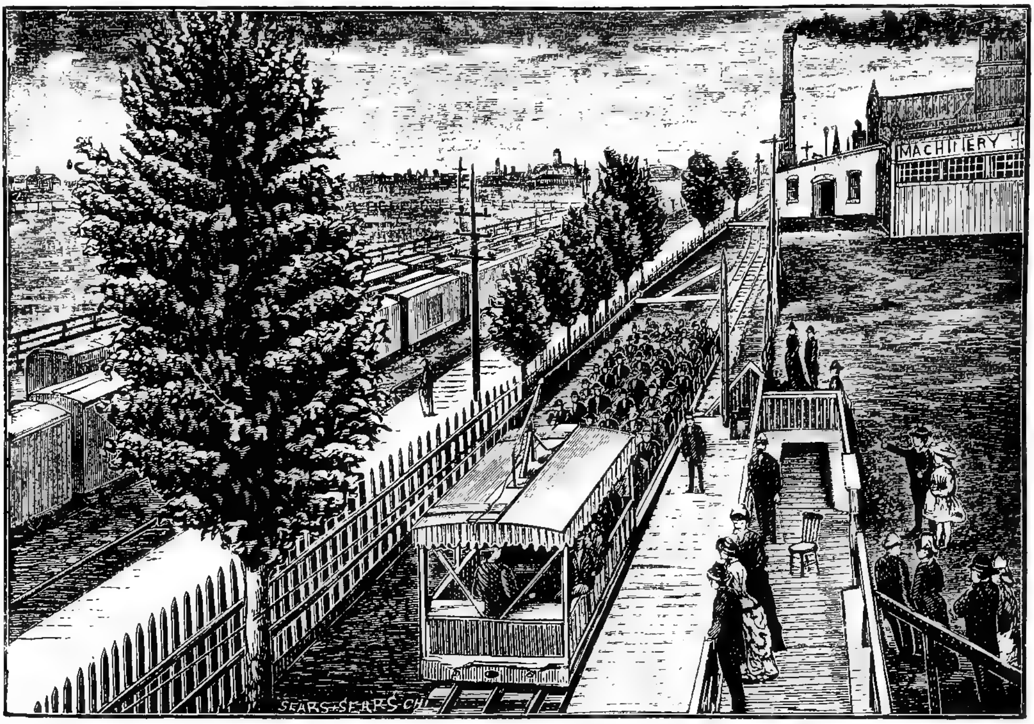
Much of the technical development of the modern electric railway is due to the intelligent experiments of Charles J. Van Depoele, a Belgian, whose father was master mechanic for the East Flanders Railway System. Van Depoele was a cabinet-maker by trade, but devoted most of his spare time to electrical experiments. He came to the United States in 1869 and located in Detroit, where he engaged in the manufacture of art furniture. This afforded him a sufficient income for the indulgence of his experimental tastes, and he designed and built some of the earliest dynamos and arc lights. His chief hobby, however, was the operation of street cars by electricity, on which he commenced work in 1882. Van Depoele, in the winter of 1882-3, operated a short experimental line in Chicago and later in the year ran a car at the Industrial Exposition in the same city, taking his current from an overhead wire. The results were so encouraging that in 1885 he made a contract with the management of the Toronto, Canada, Exhibition to build and operate a motor car and three passenger cars on a single track line about a mile long connecting the existing street railway terminus with the exhibition grounds. This venture was a distinct success, a traffic of 10,000 passengers a day being handled. At times speeds up to thirty miles an hour were attained. On this motor car was installed the first "underrunning" trolley, now generally used. In a crude form this little road used the modern central overhead trolley wire, underrunning trolley and trolley pole, side bracket poles for suspending the trolley wire and the insulated track return. It has been said that this was not a street railway in the strict sense of the term, although it used streets as thoroughfares.

Shortly after his experience at Toronto, Van Depoele undertook the construction of a real street railway at South Bend, Ind., on which five separate cars were operated at one time, something undreamed of up to then. Current to operate this road was obtained from a generating plant driven by water power. On each of the four closed cars was placed a five horse-power motor and a larger open car was equipped with a ten horse-power motor. On all the cars the motor was placed under the floor between the wheels. The axles were connected by link belts and sprockets. This was an innovation which was desirable, because the motor was in the way when located on the platform and took up space needed for passengers. On this line Van Depoele tried the experiment of attaching to the trolley wire a little car connected by a flexible cable with the motor on the big car on the track. While a perfect contact was made, this idea as well as an underrunning trolley held in place by a balance weight, were later abandoned for the underrunning trolley. In 1885 Van Depoele contracted with the New Orleans Exposition to build a road almost a mile long with a carrying capacity of 200 passengers and equipment consisting of a motor car and two large open passenger cars. Following this contracts were undertaken for roads at Minneapolis, Minn.; Detroit, Mich.; Appleton, Wis.; and Montgomery, Ala. This latter road began service in 1886 and was equipped with twelve cars.

Van Depoele's work and inventions, particularly the underrunning trolley which is a vital feature of the modern electric railway, created a great deal of discussion about this time and formed the subject of litigation. The courts sustained his claims as the inventor of this useful device and Judge Townsend, of the United States Circuit Court, said:

"No one can read this record without being impressed by the fact that Van Depoele was more than a skilled mechanic in the art of electrical propulsion. The Patent Office has raised a presumption in his favor as an inventor by the grant of numerous patents to him. Some thirty have been introduced by complainant, several of which cover highly meritorious inventions which have largely contributed to the successful practical operation of the trolley roads throughout the country. In fact, the construction covered by his earlier patent for an overhead underrunning trolley shows that he appreciated the problems involved in varying lines and curves, and to a limited extent by said device ingeniously provided for their solution."

In 1884 Edward M. Bentley and Walter H. Knight built and operated at Cleveland, Ohio, an electric railway on the open slot conduit principle. It was a very expensive installation and was the first electric road to run in competition with horse cars on regular street railway lines. Two miles of the tracks of the East Cleveland Horse Railway Company were equipped with a small underground conduit located between the track rails and running the length of the road. The feeder conductor was placed in the conduit, and current at high voltage for the Brush series wound motor was picked up by a "plow" which extended down from the car through the slot in the conduit and, by sliding contact, maintained electrical connection with the source of current. The first car so used was an old horse car equipped with a small arc lighting dynamo operated as a motor. Two other cars, similarly equipped with motors, but with variations in gearing, were also put in service, the last being supplied with spur gears. These were built up of paper to deaden the noise. In many respects this line was the pioneer of the conduit systems since operated successfully in many of our largest cities. It seems to have worked well in practice, not only in ordinary weather, but through an unusually deep snow in the winter of 1884-5. A similar Bentley-Knight system was installed in Fulton street, New York City, with the conduit slot at one side instead of between the rails. For some reason this road was



The Van Depoele Electric Railway at Toronto, 1885

never operated and later was removed. In Boston a Bentley-Knight system was installed by the West End Street Railway Company on a section of Boylston street, but this was afterwards replaced by the overhead trolley system. Apparently the time was not ripe for the introduction of this type of construction in spite of the fact that it had proved itself to be successful.

which ran along the under side of the wire, which it also gripped. In was connected by a flexible cable with the motor on the car below and was trollied or hauled along by the movement of the car on the tracks. Henry's employees and the local public called the little carriage a "troller," which later was changed to "trolley." This was many years before trolley roads became popularly known as such.

View of the Montgomery, Alabama, early Electric Line

About this time John C. Henry, a telegraph operator possessed of considerable ingenuity, was doing some pioneer electric railway work at Kansas City, Mo. A railroad had been projected to run from Kansas City to Independence, a distance of about ten miles. With the idea of demonstrating the merits of electric traction to the promoters of this line, Henry built a little experimental road at Westport on which several new features were introduced, the credit for which was claimed by him. He used double overhead wires supported both by brackets and by span wire construction. In his opinion, the word trolley originated on his Westport line. His first travelling contact was in the form of a little four-wheeled carriage

Henry used as his motor a Van Depoele dynamo of five horse-power capacity mounted in an iron frame with variable speed changing gears. It was regulated by the use of resistance. This road was visited and inspected by many people interested in electrical railway development, including Van Depoele. In the latter part of 1885 Henry changed his base of operations from the Westport road to a steam railway line owned by the Fort Scott & Gulf Railway Company. Here, with heavier machinery, he made numerous experiments with high speeds, hauling freight cars and with snow and grades. During the winter of 1885-6 Henry undertook to equip the East Street Railway in Kansas City. This line had a mile of track com-

pleted and four motor cars were placed in service on it. Each car was provided with a twenty-five horse-power motor with fields so wound that their resistance could be varied and the motors regulated without the use of separate resistance boxes. The current was supplied to the motors at a pressure of 500 volts. In 1887 Henry took contracts to build and equip several roads in California, the machinery for which was built in a crude way in Kansas City. It has been observed that Henry's efforts were remarkable in that he was so remote from the facilities necessary for good scientific work.

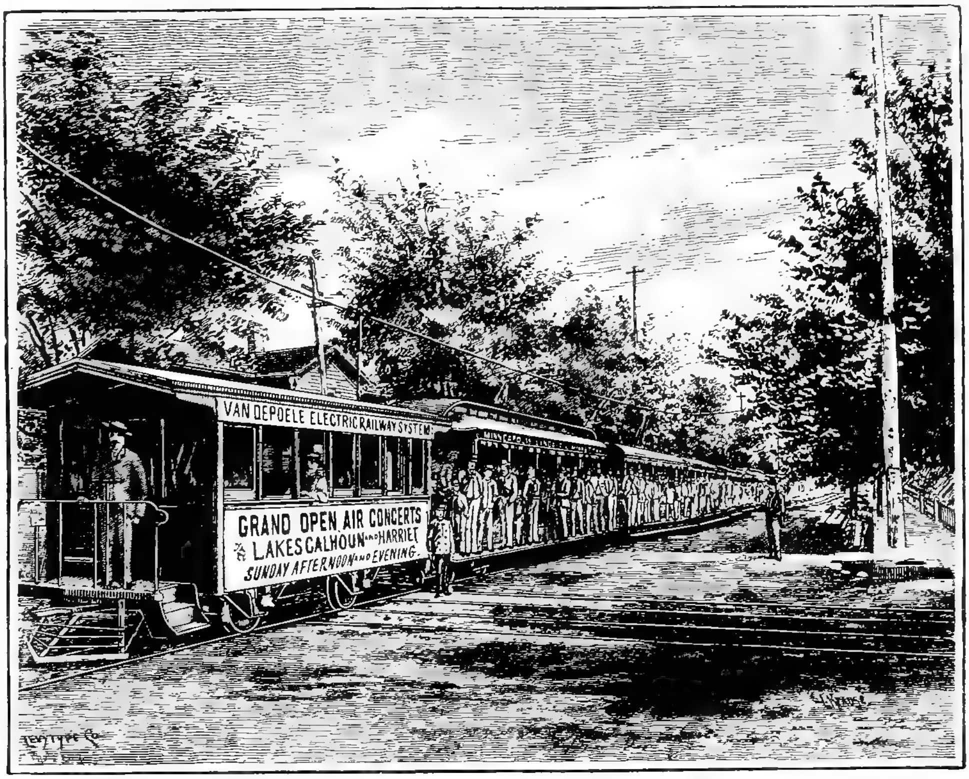
Prof. Sidney H. Short was at this time in the physics department of the University of Denver and was also engaged in experimental electric railway work. In February, 1885, the Denver Electric & Cable Railway Company was organized to build and operate an electric railway through the streets of Denver. An experimental track some 400 feet long was laid in a circle on the university grounds and Short's car, called the "Joseph Henry," hauled many hundreds of persons over it. The attention attracted by these efforts led to more ambitious attempts, which, however, were not successful. Short, at this time, held the opinion that the greatest economy in the operation of electric railways could be attained by the use of the series system, as in arc lighting. For several years, with much perseverance and ingenuity, he endeavored to produce a practical system operated in this way until at last the success of the parallel system persuaded him to turn his attention to that method of operation. He also devoted himself to improving motor construction and methods of motor suspension on the car. He was among the very first to recognize the advantages of spur gearing with double reduction of speed for the motors used.

With due allowance for the pioneer efforts of the early experimenters and with proper credit to all the inventive genius displayed, as well as for the propaganda carried on to educate the public and the investor, it must be said in all fairness that the first of the really modern systems to be equipped and operated by electricity under service conditions was that built at Richmond, Va., by Frank J. Sprague in 1887. It has been in continuous and successful commercial operation ever since. The modern era in street railway development begins with this date.

As a lieutenant in the United States Navy, Sprague had devoted much attention to electrical matters in which he had been interested from early youth. As a designer of one of the earliest forms of the modern power motor he had been encouraged by Edward H. Johnson, then the active head of the Edison lighting system. Through Johnson's co-operation Sprague was enabled to perfect his motor and introduce it in a large way on the low tension circuits of the Edison lighting companies scattered all over the country. Although the prospect of financial reward loomed large in this particular field, Sprague and his associates turned their attention to the electric railway. At this time all the existing roads were very short and each operated but a few cars.

In 1887 Sprague secured from the Union Passenger Railway at Richmond a contract for the complete equipment in ninety days of an electric railway with thirteen miles of track and forty cars. It was stipulated that thirty cars should be operated at the same time. The contract involved building a generating station and pole lines for the transmission of current as well as the erection of the trolley wire, the laying of the track and the building of the motors and the cars. The number of cars specified in this contract was greater than the total of all the electric cars then in service in the whole of the United States. The grades in Richmond were generally believed to be beyond the climbing capacity of any electric motor then known. There were twenty-nine curves on the road, five of them less than thirty feet radius, and some of the grades were as high as twelve per cent. The track was laid with twenty-seven pound rails, loosely jointed, and the ties rested in Virginia clay. After considerable experimental work and all sorts of disasters and troubles, the road was opened for regular service about February 1, 1888. The story is told that during one of the trial trips a motor on a car jarred loose and that Sprague crawled beneath the car and held the motor in place by main strength until the run was finished.

A small overhead trolley wire was used with which the underrunning trolley made contact reenforced by a main conductor supplied with current by feeder circuits from the generating station. The track was used as the return circuit. The rails were not only bonded together, but were connected to a continuous conductor which, in turn was connected with ground plates and with the gas and water pipes of the city. The motors operated on the parallel system under a voltage of 450. There were two motors under each car, flexibly suspended. Single reduction gears connected the armature shaft with the car axle. The motors had fixed brushes and were operated by the motorman through rheostatic series parallel controllers with sectionalized field coils at each end of the car. There was a commutator at each end of the armature, cross connected one with the other, so that but one top brush on each commutator was used. After a short time the single reduction gears were abandoned for double reduction gears, but these were soon replaced again by single reduction gears. The motors proved to be so inadequate for the rough work demanded of them that they had to be practically rebuilt. Up to that time it had been believed generally that a sixteen-foot car easily could be operated by a pair of seven and one-half or ten horse-power motors. It now was discovered that while but one or two horse-power was required to keep a car in motion, a great deal more was necessary to start it from rest, especially if it was fully loaded with passengers. From this time on the capacity of railway motors was largely increased.



The Van Depoele Electric Line at Minneapolis

As the motors were run exposed to weather, mud and dust, it was necessary that their installation be very thorough, and great pains were taken to accomplish this. The brushes on the motors, at first, gave almost constant trouble. In connection with the overhead system much difficulty was experienced, and Sprague has stated that at least fifty varieties of trolley

wheels and poles were experimented with before what is now known as the "universal movement" type was developed and adopted. Overhead construction at curves, switches and turnouts had to be worked out in a similar manner.

The Richmond road continued to operate, in spite of all difficulties and setbacks, and gradually attracted the favorable attention of financiers and street railway men in other parts of the country. About this time one of the most extensive street railway systems in the United States, the West End Railroad of Boston, was considering the equipment of its lines with the cable system on the theory that it alone could operate a large number of cars simultaneously. On a visit to Richmond the president and other officials of the West End road were shown an experiment which settled the fate of the cable system in Boston. Twenty-two motormen started up their cars, one after the other, as rapidly as headway could be obtained.

Ice and sleet on the trolley wire at Richmond often made it necessary for a man to ride on top of the car and knock it off with a stick as well as to hold the trolley by hand in contact with the wire. Lightning played havoc with the system, as there was no protection in the form of lightning arresters and there were many grounds through the motors and lamp circuits. This finally was overcome to an extent by the use of choke coils and arresters of a primitive character.

As Van Depoele perfected the underrunning trolley, so the credit for pioneer work in the suspension of the motor under the car must be, as it has been by the courts, awarded to Sprague. This, of course, like the underrunning trolley, was the subject of litigation. A decision by Chief Justice Shipman, of the United States Circuit Court of Appeals, says in part:

"As soon as the use of an electric motor for the propulsion of cars upon a street railway was thought to be attainable, divers methods were invented which were intended to enable the motor to act efficiently, economically and certainly upon the car axle. At first the motor was supported by or on the car body and afterwards it was upheld upon a separate platform. Sprague hung the motor under the car body directly upon the axle of one of the pairs of wheels by an extension or solid bearing attached directly to the motor. He used a magnet having a yoke and pole pieces, and by sleeving one end upon the axle he caused the armature, which was carried between the poles of the magnet, to be held with firmness and the armature shaft to be held in alignment with the car axle. The opposite end of the motor was upheld by springs extending to a crossbar on the truck frame. He also relieved the weight upon the axle by a spring support from the truck of the vehicle. The motor was thus hung below the car, one end being centered upon the axle and the other end being flexibly attached by springs to the truck frame. The effect of the mode of construction is explained in the specification as follows: 'The armature being carried rigidly by the field magnet, these two parts must always maintain precisely the same relative position under every vertical or lateral movement of the wheels or of the car body; and as the field magnet which carries the armature is itself centered by the axle of the wheels to which the armature shaft is geared, the engaging gears must always maintain precisely the same relative position. At the same time the connection of the entire motor with the truck is through springs, so that its position is not affected by the movements of the truck on its springs.' The simplicity and comparative lightness of the general plan upon which this motor was constructed and the adaptability of the means to the required result made the motor successful, and other preexisting methods of construction disappeared to a great extent."

Elevated railways occupying main lines of thoroughfares must be considered in the development of the passenger-carrying street railway. This system of transportation is peculiarly American in its origin and adoption. New York, Boston, Chicago, Brooklyn and Kansas City all have elevated railways which are now component parts of the surface street railway systems, operate under the same management and transfer passengers. Daft, Field and Sprague made some of the earliest experiments in the application of electricity to short-haul transportation on the elevated railways of New York City. For years these roads had been operated with steam locomotives, but the rapidly in-

creasing traffic necessitating heavier and faster trains as well as the objection of the public to the noise and dirt of the steam locomotives afforded an opportunity for these pioneers to work out their ideas in practice. As early as 1885 plans were made for equipping sections of the Ninth avenue and Second avenue roads in New York with electricity.

Van Depoele and Some of his Early Electric Light and Railway Associates. The Group Comprises Frankland Jannus, John Cook, John Van Hoogstrate, James McLaughlin, Gen. Stiles, C. J. Van Depoele, Frank Sheal, Albert Wahl and Elmer P. Morris

From the collection of Elmer P. Morris

Leo Daft installed a third rail system on a two-mile stretch of the Ninth avenue line from Fourteenth to Fifty-third street. The third rail, which fed the current to the motors, was laid between the track rails, which latter were used as the return. The Daft electric locomotive weighed nine tons, was fourteen feet six inches long and four feet eight and one-half inches wide. Its driving wheels were forty-eight inches in diameter and the motor was seventy-five horse-power, with a normal speed of eighteen miles per hour and a maximum of forty. The motor was supported at the rear by a shaft resting in bearings. The forward end of the motor was supported by a long screw which passed through a threaded nut or eye. A hand wheel for turning the screw was attached to it. The armature shaft was provided with a friction wheel nine inches in diameter which bore upon another friction wheel three feet in diameter geared to the axle of the main driving wheels. By turning the hand wheels on the screw the upper friction wheel could be pressed against the lower to any desired degree. In this manner, therefore, power was transmitted by friction from the armature to the driving wheels,

the amount of friction contact being regulated at will by the operator in direct proportion to the load. Thus was the necessity for sprockets, link belts, etc., avoided. The screw also afforded a convenient means for raising the motor clear of the driving wheels so that the armature could be inspected and repaired when necessary. Electric brakes also were used on the Daft locomotive. These consisted of large electro-magnets energized by current from the track so that they were attracted by the wheels and came into mechanical contact with them as an ordinary brake would. The motors were compound wound and the terminals of the windings were carried to a regulator near the motorman at the front of the locomotive. By the movement of a lever across the terminals the resistance of the field magnets could be changed, resulting in corresponding variations in the speed of the motor. A bronze contact wheel fifteen inches in diameter was used to pick up the current from the third rail. The motor was afterward rebuilt, as it proved to be too light for the work demanded of it.

In the meantime, Stephen D. Field, representing the company which had acquired Edison's and his own electric railway patents and inventions, had begun electrifying the short piece of elevated track which connected the Thirty-fourth street station of the Second avenue line with the ferry house at the foot of Thirty-fourth street, New York City. The locomotive which he put in service here was the first which bore any external resemblance to those which later were to be generally adopted. In Field's locomotive the motor shaft was directly connected with the driving wheels by a crank and side bar, exactly as in the steam locomotive. The motor was mounted on the rear truck and was series wound. A new feature of this equipment was that the motor was regulated through a liquid rheostat or resistance placed in the cab. This was in the form of a trough divided into two compartments and filled with acidulated water. Metal plates at either end of the trough acted as terminals for the feeding circuit which was brought in over two copper cables. By inserting or withdrawing two slate slabs from the trough through the operation of a long lever, the resistance could be varied from almost zero up to any desired point, thus regulating the speed of the motor and that of the train. Other ingenious devices were used for reversing and for shifting the brushes to prevent commutator sparking. This locomotive, which was often operated under a potential as high as 1,100 volts, weighed thirteen tons and hauled up grade at eight miles per hour one of the regular heavy elevated coaches.

Frank J. Sprague now came forward with the proposition that the correct way to haul a train was to equip each car with its own motor, the pioneer idea of the multiple unit system of the present day. He urged the abolition of the electric locomotive for elevated railway service. His arguments must have been sound and conclusive, for the locomotive has been replaced by the motor car. Sprague began a series of experiments on the Thirty-fourth street branch of the Third avenue elevated road in New York. He equipped a car with two motors, one on each truck. By connecting the motors in parallel on a constant potential circuit and driving from opposite ends of the motor shafts, and by having an intense magnetic field and raising the potential of the armatures gradually, a very intense torque, or rotary effort, was secured which enabled the car to start quickly. Trials also were made of a braking system which involved converting the energy of the train into current, delivered back to the line from the motor which, for the time being, became a dynamo without reversal of contacts. Three contact conductors, two of which were bronze wheels working on pivoted arms under compression springs, were used to pick up the current from a central third rail. For handling the motors, breaking the main circuit, reversing the armature circuit, cutting the armature partially out of the line, and closing it upon a local regulating apparatus, special switches were designed and installed. Current at about 550 volts was used. This was obtained from five Edison incandescent lighting dynamos connected in series. These were located about a mile away and the current was carried to the experimental track in cables strung on Western Union telegraph poles.

In spite of the success of these efforts and the fact that many new and ingenious features were developed through them, it

was not until fifteen years later that electricity was finally adopted as the motive power for the New York elevated railway system, although meanwhile it had been successfully applied to the elevated systems in Chicago, Brooklyn and Boston. The management of these latter roads had been convinced by a demonstration made at the World's Fair in Chicago in 1893.

The Intramural Railway was an elevated structure which made almost the complete circuit of the World's Fair grounds, and was nearly three miles in length. It comprised 14,800 feet of double track and 1,900 feet of single track. Fifteen trains, each consisting of a motor car and three trailer cars, were operated over the road. The cars were fifty feet in length and were mounted on double trucks. The motor cars weighed thirty tons each and each trailer, when loaded, weighed twenty-two tons. Four motors, one on each axle, were installed on each motor car. The motors were of the single reduction type, geared so as to operate at a maximum speed of thirty-five miles an hour, and each had a capacity of about 135 horse-power, thus providing each motor car with over 500 horse-power. A sliding contact on the motor car picked up the current from a third rail placed outside the traction rails. A special power station was built to supply the road with current. It had a capacity of 2,000 horse-power, the largest known up to this time in connection with electric railway work. The Intramural remained in successful operation throughout the World's Fair and is reported to have safely transported in one day as many as 125,000 passengers. From this time on no doubt remained as to the practicability of operating extensive systems of elevated railway by electricity.

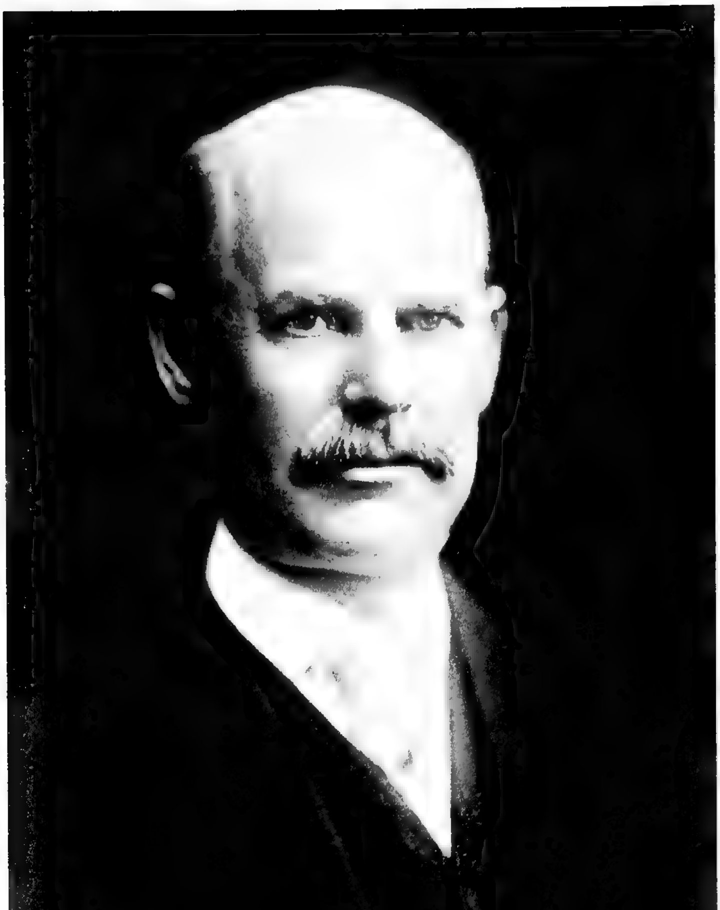
The many obvious advantages of a self-contained vehicle led a number of experimenters to attempts to adapt the storage battery to passenger transportation over street railways. These efforts were at first most promising and very interesting, but gradually for one cause or another all were abandoned. The theoretical advantages of a system which does away with overhead construction, underground conduits, and which is not affected by a temporary shut-down of the electric power station are most appealing, but they are overcome in practice by inherent disadvantages of the storage battery system which have demonstrated after many attempts that it is not suitable for street railway work. Both in Europe and in the United States experiments in storage battery traction were tried as early as 1880 and 1883. Probably the most ambitious work of this kind was undertaken in New York in 1887 and 1888, when the system of Julien, a Belgian engineer, was in operation for a considerable period on the Fourth avenue street railway line. As many as twelve cars were in service at one time. C. O. Mailloux, of New York City, made many modifications in the Julien system and excellent results were obtained. Anthony Reckenzaun, of Vienna, also made some encouraging experiments at Philadelphia.

The Mahoning and Shenango Railway and Light Company's Type of Modern Car

It was found, however, that the type of storage battery then obtained was inadequate for this service. They broke down very rapidly under the heavy discharge

required at intervals and tended to short circuit themselves from the jolts and concussions of the car on the tracks. The weight of the cells used in these early experiments proved a severe handicap. Most of the cells tried weighed from 100 to 125 pounds per horse-power hour of energy stored, which, of course, limited the operating radius of the car greatly. Cells with an output of one horse-power per hour for fifty to seventy-five pounds of weight were designed, built and tried, but they proved too fragile for the service required. The annoyance to passengers from sulphuric acid fumes which escaped from the batteries carried under the seats proved to be an insurmountable difficulty. The jolting of the car also threw out the acid from the cells and it quickly corroded and weakened the structural material of the car. Trouble also arose over the handling of the exhausted batteries at the power station when they had to be replaced by freshly charged cells. Many ingenious devices were contrived to do this work quickly. Finally, in order to do away with the necessity for such devices it was decided to leave the batteries on the cars all the time and charge them in place. But this necessitated the doubling of the rolling stock. Although experiments continued with varying success over a period of years, the last of the street cars operated with lead batteries in New York were withdrawn from service in 1903. Since then a number of cars equipped with the Edison cell have been in operation. In 1907 there was but one road, with three miles of track, operated by storage batteries. In 1912 ten street railway companies were using storage cells over at least a part of their systems and the track mileage had increased to 64.67, nearly all of which was in the states of New York, Pennsylvania and Delaware.

In 1913 a demonstration was made to show the value of the storage battery car for lighter traffic on the main lines of steam railroads, although no great progress in this direction has been made since. The experimental run from New York to Boston, a distance of 307 miles, was made on March 6, 1913, in eleven hours, six minutes and fifty-one seconds. The route taken was from New York to Albany over the tracks of the New York Central and from Albany to Boston over the Boston & Albany. The weather conditions during the test were as follows: From New York to Poughkeepsie, light rain; from Poughkeepsie to Hudson, light snow; from Hudson to Chatham, heavy snow; from Chatham to Springfield, high cross wind and drifting snow; from Springfield to Boston the temperature was six degrees above zero. The car was forty-nine feet, eight and one-half inches long over the drawbar, and was equipped with 225 cells of nickel-steel alkaline batteries for power and five cells for light. The batteries were located under the car in two compartments strongly reinforced with structural shapes and riveted to the underframe. Driving power was obtained through four twenty horse-power, seventy-five ampere, two hundred volt, series wound motors. The wheels were driven by gears placed on the inside exterior of the hubs, the reduction being at the ratio of two and one-half to one. The body of the car was divided into two compartments, one for baggage, eleven feet ten inches long, and the other for passengers, thirty feet two inches long with seats for fifty-one persons. The car without battery and passengers weighed 48,235 pounds; standard battery, 8,525 pounds; auxiliary battery, 8,525 pounds; light battery, 266 pounds; accessories on car, 500 pounds. During the run the average speed was 27.6 miles per hour and a maximum speed of 42 miles per hour was attained. The total number of kilowatt hours used was 369.1 and the average kilowatt hours per car mile were 1.2.



DR. EDWARD G. ACHESON

DR. EDWARD GOODRICH ACHESON

The world has been made over and speeded up during the past one hundred years and, except for the electric telegraph, has been electrically equipped during the past fifty. Space annihilated; light, warmth and motion multiplied to proportions undreamed of; machines increasing production by the thousand-fold; new resources uncovered for varied human needs, and the former luxuries of the rich transformed into the necessities of the many—all these things have come through the genius of inventors who have translated the discoveries of science into the actualities of industry.

Many of those most prominent as factors in this material advancement are our contemporaries, still faithfully working for the fulfillment of the programme of progress. Among them none is more active in accomplishment or more versatile in labors than Dr. Edward Goodrich Acheson, who stands in the front rank as the result of achievements in scientific discovery and revolutionizing invention. His genius has traversed many fertile fields of scientific endeavor. He is an electrical engineer of long service and valuable achievement. His greatest discoveries have proceeded from novel applications of heat generated in an electric furnace. He is a chemist who, through electro-chemical means, has made the most valuable dicoveries of abrasive materials and lubricants. His very substantial success and present world-wide prominence have been largely accomplished by electrical means, and, although his career has covered work in many vocations, it is in electrical and chemical lines that his highest endeavors have been enlisted.

Dr. Acheson comes of that sturdy Ulster stock from which came the most prominent of the early settlers of Western Pennsylvanian in the closing decades of the Eighteenth Century. His grandfather, David Acheson, came from Glassdrummond, County Armagh, Ireland, in 1788, and settled at Washington, Pennsylvania, where the family has since been prominent in public and professional life. David Acheson and his brother, John, engaged in business at Washington, and did an extensive business with the United States Government in furnishing supplies to the Army and to Indian reservations. David Acheson was not only a successful business man, but a legislator of prominence, serving three terms in the General Assembly of Pennsylvania. Of his sons, Marcus W. Acheson was on the district and circuit bench of the United States for twenty-six years, whose son, Marcus W., is a prominent Pittsburgh lawyer. Judge Alexander Wilson Acheson was a judge in Washington County, and was father of Ernest Francis Acheson (Congressman Twenty-fourth Pennsylvania District 1895-1909). A third son of David Acheson was William Acheson, iron manufacturer, merchant, and a man of considerable scientific attainments. He married Sarah Diana Ruplé, and of that union Edward Goodrich Acheson was born at Washington, Pennsylvania, March 9, 1856.

He received his education at the Bellefonte (Pennsylvania) Academy until, at the age of sixteen, he was taken from school to fill a position at his father's blast furnace. In 1873 his father died, and a sort time afterward Edward G. Acheson joined a surveying party as chainman. For some time he lived an unsettled life, trying his hand at various occupations but showing his mechanical and inventive bent by inventing a drill for coal mining before he was eighteen and later constructing a dynamo. He was employed, successively, as railroad ticket clerk, engineer, bookkeeper and iron miner until 1880, when he went to New York, hoping to find employment which would help him to better knowledge and experience along electrical and chemical lines.

He was fortunate enough to find a place as assistant draftsman in the laboratories of Thomas A. Edison, at Menlo Park, New Jersey, then a fountain head of chemical knowledge and experiment. His promotion, soon afterward, was to a place in the original experiment department, where he was in close touch with many of the most important of the then current electrical problems. His progress may be readily inferred from the fact that in July,

1881, he was sent as first assistant engineer of the Edison interests at the Electrical Exposition in Paris, where many wonderful exhibits of progress in things electrical were on exhibition, for it was a period when many of the giant steps in new electrical paths were being made. When the Exposition was closed he remained in Paris with the Edison Company and later was in Italy for a time with the Italian Company that operated the Edison patents, returning in 1883 to Paris, where he put in several months doing a considerable amount of experimental work on his own account. The problem upon which he was working was one which had long and deeply interested him—the direct conversion of heat into electrical energy. The experiments exhausted his life's savings, and illness added to the seriousness of his plight. He returned to the United States with means so reduced that he found it necessary to take a salaried position, becoming superintendent of the Consolidated Lamp Company, in Brooklyn, New York, and remained there for a year, 1884-1885.

Having invented an anti-induction telephone wire, he sold it in 1885 to George Westinghouse, and from 1886 to 1889 he was electrical engineer with the Standard Underground Cable Company of Pittsburgh. The spirit of experiment was strong within him, and electrical and chemical problems engaged his spare hours. After leaving the service of the Standard Underground Cable Company he devoted his entire time to these experiments.

One of the subjects of experiment which had long occupied his attention was that of abrasion. He dates his interest in the subject back to a chance remark made to him in 1881 by Dr. George F. Kunz, vice-president of Tiffany & Company and famous gem expert, which caused him to appreciate the value of an efficient abrasive to the industrial world. To quote Dr. Acheson himself, the influence of this remark had very important results. In an impressive scientific address, made in 1910, he said:

"I was even brought to realize that the act of abrasion constitutes the beginning of manufacture, man having to rub things into form before he had any tools to use in shaping his material. Several years passed by, and in 1886, while making an experiment in the gas fields of Western Pennsylvania, I placed a number of clay articles in a kiln, into which, when brought to a very high temperature, was introduced some natural gas, and after the kiln had been cooled and the clay articles removed, they were found to be of a dead black color, and I thought were harder, they having been impregnated throughout with carbon resulting from the decomposition of the gas. Five more years passed by until, in March, 1891, having opportunity to use a comparatively large electric current, I thought I would then take up a series of experiments for the production of an artificial abrasive. These experiments resulted in my devising methods whereby a mixture of ground coke and sand, when subjected to a high temperature in an electric furnace, were caused to undergo chemical changes, the oxygen of the sand passing off with the carbon as carbonic acid gas, the reduced metallic silicon associating itself with an equal atomic weight of carbon, resulting in the production of a new body up to that time unknown. To this body I gave the name *Carborundum*."

In Dr. Acheson's account of this discovery is the interesting story of the initial test of the new body and its first commercial exploitation. As soon as he had enough of the Carborundum to test its abradant qualities, he mounted an iron disc in a lathe, oiled its surface, and applied Carborundum dust to the oiled disc. With the disc thus treated he ground off the high polish from a diamond, thus demonstrating that Carborundum was sufficinetly hard to cut what, up to that time, had been universally regarded as the hardest substance in the world, and proving also that the new substance was beyond comparison the superior of every other abrasive.

The experimental work upon which he had been engaged had again so depleted his savings as to give him serious forebodings, but his discovery of Carborundum encouraged him mightily. Dr. Acheson has sound business judgment added to scientific knowledge and technical and mechanical skill. The plant with which he

made the discovery had a very inconsiderable capacity for its production, and it was two months before he had produced enough Carborundum to fill a small vial. This he took to New York to have the lapidaries test its merits. One lapidary, whose shop was in John Street, tested it by using some of the dust to repolish the diamond which had been ground in the initial test. He was so impressed with the result that he bought what remained in the vial for sixty dollars. The quantity was less than one ounce, so that the first commercial quotation on Carborundum may be given as at the rate of eight hundred dollars per pound. The sixty dollars was forthwith used in the purchase of a microscope with which to study the structure of the Carborundum crystals.

Later in the year the Carborundum Company was organized, application for patent having been made, and a small plant was built at Monongahela City, Pennsylvania. The patent for Carborundum was issued in February, 1893. The increase in the production of Carborundum has steadily expanded as its uses have multiplied, and it is now sold in all the markets of the world. For years its annual production has exceeded twenty million pounds, but the price fell from the eight hundred dollars of the original quotation to about ten cents per pound in more recent years. The discovery was one of great benefit to many industries, cheapening the production of numerous articles and improving the finish of many others. More than a quarter of a century of general use has failed to present any other substance comparable to Carborundum in its abradant qualities. The growth of its demand soon outgrew the plant at Monongahela City, and in 1895 the great Carborundum plant at Niagara Falls, New York, was constructed, especially interesting to the electrical world because in it was installed and is now in use the largest electric furnace in the world.

The Niagara Falls plant gave an opportunity to carry Dr. Acheson's investigations and experiments into a far wider and more important field than would have been possible in any small plant, and these have given to the world other new products of incalculable benefit to industries of various kinds. Vastly important in results were the series of experiments which resulted in the manufacture of graphite upon a large commercial scale and in various forms for divers uses.

The experiments with the electric furnace had to do with extremely high temperatures. The manufacture of Carborundum itself called for a temperature far beyond that required for the vaporization of silica or sand, which has always been regarded as a most durable lining for metallurgical apparatus. Experiments made with the Carborundum in the electric furnace, carried to a greatly higher temperature than that required for its production, caused decomposition. The silicon portion of the Carborundum was volatilized, and the carbon portion remained as graphite.

In the original mixture from which Carborundum was derived the carbon portion was in the form of ground coke made from bituminous coal, but in the process of association with silicon at the high temperature which evolved Carborundum the still higher temperature which forced it from its chemical combination with silicon also transformed the carbon content into graphite. Chemistry, as is well known, recognizes three allotropic forms of carbon: the diamond, charcoal and graphite. Diamonds, as far as known, exist in very limited quantities; graphite in its common mineral form is found in fairly liberal quantities, but always associated with impurities; but the charcoal or non-graphitic amorphous carbon exists in very large quantities as the chief fuel unit of coal, wood, etc. Dr. Acheson's graphite discovery revealed the fact that it is possible to transform non-graphitic amorphous carbon into graphite after the manner described, and he has expressed the belief that the same process, if it were possible to produce like liberation of the carbon from the silicon under a high pressure, would produce the other allotropic form of carbon—the diamond.

Other investigations into methods for the production of graphite were incited by observations of the operation of the Carborundum furnace. The large electric currents needed are carried into the furnace by carbon conductors or electrodes. These were originally made in the form of rods

composed of coke, resulting from the distillation of petroleum, the coke being ground to powder and made into rods by being mixed with tar as a binding material, formed under pressure, heated to a bright heat decomposing and partly volatilizing the tar. In operation in the Carborundum furnace the inner ends of these rods were always converted into the graphitic form of carbon. This discovery, together with the former one of the recovery of graphite as the result of the decomposition of superheated Carborundum, led Dr. Acheson into a series of experiments for the development of a commercial method of making graphite.

His first production of commercial graphite was in 1897, when he made a little more than 162,000 pounds of graphite rods, to be used as electrodes in electrochemical work, producing them by direct conversion of the non-graphitic carbon rods (above described) into rods of practically pure graphite, without any extraneous bonding agent. These were vastly better than the original unconverted carbon rods, because they would resist disintegration and quadrupled the electrical conductivity.

The production of these graphite rods came very appropriately at a time when there was a great movement bringing about a large use of electric furnaces in steel manufacture. The old non-graphitic rods were very unsatisfactory because of their low conductivity, the difficulty of making good electrical contacts to them, and the fact that when the rod was partly consumed through the burning and wearing away caused by the high temperature of the furnace it became so short that it could not be used and about half of the electrode had to be thrown away. All these drawbacks were overcome by the use of the graphite electrode which can be tapped, threaded and screwed together and fed into the furnace as one continuous rod.

The production of graphite in bulk in the form of grains, powder, etc., was next undertaken. It was found that anthracite coal formed the best crude material for the manufacture of graphite, and the artificial production of graphite grew with a great demand. A very large percentage of the dry batteries made in the United States are filled with it, and its superiority over the impure natural graphite gave it superior spreading power, making it a most efficient paint pigment for metals, and in electrotyping it has become first favorite. In 1899 Dr. Acheson organized the Acheson Graphite Company, later reorganized into the International Acheson Graphite Company of Niagara Falls, the annual production of which exceeds 50,000,000 pounds of graphite.

The production of a graphite which in purity and quality far exceeded any of the graphites found in their natural state led Mr. Acheson to believe that he would be able to share in the production and sale of graphite crucibles for the metal industries. These crucibles are made of graphite about 60 per cent combined with 40 per cent of clay. He tried the combination, using native clays, but the crucible thus made proved practically worthless. Here was a disappointment. He found that graphite to the value of one million dollars was being imported from Ceylon each year to be used in the manufacture of graphite crucibles, and that large imports of clay were being brought from Germany for the same purpose. This seemed strange, as the German clay, though it was superior to domestic clays in plasticity and strength, proved on chemical analysis to be practically the same as American clays. Further experiment showed that for crucible purposes the Ceylon product was much the best, having a fibrous structure and much greater density than the purer artificial product.,

But the clay problem was one that remained to challenge the scientific mind of Dr. Acheson, and led him into a fruitful field of investigation and experiment which yielded valuable data in regard to the characteristics of domestic clays and methods for increasing their strength and plasticity. He found that clays procured near the source from which they were derived—the decomposed feldspathic rock technically known as "residual clays" — were very weak and had little plasticity, while the clays at a river bottom, carried by water from the source, were much stronger and more plastic and were known as "potters' clays." Solution of the problem was not aided by chemical analysis which showed

little difference between these two kinds of clay. Dr. Acheson therefore concluded that the difference was due to some physical change undergone by the clay during its transference by flowing waters from its source to its final bed. This physical change he judged to be due not to the action of the water itself, but to impurities in the water, received from the washings from forests and plains, composed of organic matter derived from plant life. Among the various experiments based upon this theory was one in which a weak, non-plastic clay was treated with a dilute solution of tannin. Under this treatment the clay was increased in plasticity and strength, and was so subdivided that it would pass through a filter paper and would not settle in water for an indefinite period. Tests of this process showed increase in tensile strength reaching, in some cases, to 300 per cent. One very definite test was made with a batch of clay of which one part was, without tannin treatment, made into a briquette and burned, and the other part, treated with the tannin solution, was sundried. In subsequent test the sundried briquette proved to have much the greater tensile strength.

Gratified with the demonstrated efficacy of this tannin treatment Dr. Acheson, realizing that clay work was one of the oldest forms of industry, searched all the literature he could find available to see if there was any mention of similar phenomena in relation to clay. He found none, the nearest approach to it being the Bible account of the Israelites in Egyptian bondage using straw in the making of bricks, and later successfully substituting stubble for the straw. The generally accepted explanation of this method is that the straw was used in the clay as a binder, after the manner now applying hair as a binder for plaster. But Dr. Acheson reasoned that straw is such a weak fibre as to be an absolutely ineffective binding agent, and therefore must have been used for some other reason. At the same time straw contains no tannin, so that its value to the brick must have had some other basis than any revealed by Dr. Acheson's tannin-solution test. To explain the problem of the value of straw in brickmaking, he boiled some straw which lost half its weight in the process and produced a yellow-brown liquid. Clay moistened with this liquid and made into a briquette was found to have the same characteristic of increased strength and plasticity as that treated with tannin. Dr. Acheson, assuming after this test that the Egyptians were familiar with the effects thus produced, named the treatment "Egyptianizing" and named the treatment "Egyptianized clay."

Another valuable discovery made by Dr. Acheson came in the summer of 1906. When he was making an experiment in the electric furnace having nothing to do with graphite, he found in the output of the furnace a small amount of a very soft, non-coalescing graphite, which he recognized as being of a quality valuable as a lubricating graphite. The graphite produced by his previous process had been too hard to use as a lubricant, and when ground or rubbed it would coalesce into a more or less solid mass and would not disintegrate. The new graphite, which is distinguished as "Lubricating Graphite," is now made by a process of Dr. Acheson, patented in 1906.

This unctuous, non-coalescing graphite is commercially manufactured from the cheaper grades of anthracite, even the large piles of culm which are the waste of the anthracite mines in Eastern Pennsylvania. In its manufactured form it is guaranteed to have a purity of 99 per cent, but in actual practice none goes onto the market that is not at least 99.5, while its average analysis from the electric furnace ran as high as 99.8 per cent. Reduced to a degree of disintegration so fine that 99 per cent of it will go through a sieve having 40,000 meshes per square inch, it can in some cases be used dry, but is more generally used with greases of varying consistency in ball-bearing races, transmission cases, grease cups and, in fact, any place where it has been the custom to use plain greases. The grease is used simply as a vehicle for the graphite which effectually protects the gears and other metal parts from wear.

As grease lubrication, while important, only includes a small part of the field of lubrication, Dr. Acheson decided on experiments to make it available for use in those branches of lubrication performed with oil. To adapt it to this purpose it

was absolutely necessary that the lubricating graphite should be made to remain permanently suspended in a liquid, which further required a much greater subdivision of the graphite than was attainable by ordinary mechanical subdivision. Late in 1906 he determined to try on this graphite the same process which he had applied to clay. The application of the tannin to the clay had not only increased its strength and plasticity but had made the clay subdivisible to a practically impalpable degree, so that it would remain permanently diffused in water and pass through filter paper. The same process with the ingredients changed to graphite in the dilute solution of tannin, had an exactly parallel result, the graphite being made so fine that it would pass through the finest of filter paper. The result of this experiment in the perfect deflocculation of the graphite was the creation of two new lubricants, one in which the graphite content is permanently suspended in oil and another in which it is permanently suspended in water. To designate the three kinds of graphite lubricants Dr. Acheson coined names distinguished by the suffix "dag" (from the initials of "DeflocculatedAchesonGraphite"), the grease combination being named "Gredag," that in oil "Oildag," and that in water "Aquadag."

The experiments of Dr. Acheson in the creation of these lubricants further elaborated established an instructive scientific principle applicable far beyond the very valuable results in lubrication. The deflocculation did not come from the mechanical pulverization. The dry powdered graphite mixed with clear water did not pass through the filter paper. The same amount of equally powdered graphite placed in a second beaker of water, to which a small amount of organic matter was added, made a black liquid, carrying water and graphite in perfect mixture through the filter paper. The deflocculation resulted from the organic matter admixture. Another phenomenon was the fact that the water-graphite mixture ("Aquadag") remained in a bottle for a year without any indication of settling, but if a few drops of hydrochloric acid were added it began to settle, the process being greatly speeded up by warming the mixture. Then, pouring the mixture on to a filter paper, a colorless liquid goes through and the graphite remains on the paper, perfectly flocculated, the particles being of a size that prevents their passage through the filter paper.

The Aquadag is scientifically phenomenal, apparently setting at defiance the laws of gravity, because the graphite weighs approximately two and a quarter times the weight of the water. But this seems to show that after its deflocculation the question of gravity is one dealing with molecules rather than masses of the material. Reflocculation may be accomplished by a solution of ordinary salt or lime water as well as with the acid.

Dr. Acheson has well argued that in his experiments with the deflocculation of clay and later adding acid, a solution has been found for the apparently similar processes revealed in Nature. The waters of the Missouri and the Mississippi are always muddy, while those of the Ohio and Allegheny rivers are always clear except in flood seasons. The muddiness of the Mississippi and Missouri is generally attributed to the rapidity of their flow, but, as a matter of fact, the Ohio and Allegheny are the more rapid streams. Dr. Acheson explains the difference in the light of his own discovery of a process for deflocculating non-fused, non-soluble, non-metallic, inorganic amorphous bodies. The waters of the Ohio and the Allegheny are impregnated with lime and salts in quantity sufficient, under ordinary conditions of flow, to precipitate such particles as find their way into those streams, but the Mississippi and Missouri, whose waters are neutral, carry a large amount of organic matter, in suspension, and continue this colloidal condition until, when the Gulf is reached, the salt waters reflocculate the floating particles and precipitate them, forming the bars that obstruct the mouths of the Father of Waters.

The lubricants created by Dr. Acheson's genius are not only approved by the tests of distinguished scientists, but also by actual use extending to all parts of the world. These graphite lubricants give much lower friction than that accompanying any plain lubricating oil. The practical use of Oildag in the lubrication of automobiles has

been subjected to the severest tests, resulting in much better lubrication without occasion for regrinding of valves or renewal of spark plugs. Oildag is oil carrying 0.25 of one per cent of its weight of deflocculated graphite. Not only is the lubrication better, but the cost is greatly reduced. Summarized, the advantages of Oildag in the lubrication of an automobile engine are: Increased power; prevention of pitting of the valves; prevention of the smutting of the spark plugs; decreased oil consumption; decreased gasolene consumption; absolute freedom from smoke in the exhaust; prevention of wear between the cylinder walls and the piston rings; decreased amount of carbon deposited in the cylinders, and practical elimination of the abrasive action of the carbon set free from the oil.

Aquadag is equally efficient as a lubricant. This is a combination of water with 0.35 of one per cent of its weight in deflocculated graphite. It is superior to petroleum lubricants because of its entire absence of viscosity. It operates in the same manner as Oildag by depositing an extremely thin film of graphite which covers the metal surfaces and makes it impossible for abrasion to occur. It can be used where it would not be possible to use water in any other combination, the well-known action of graphite making it impossible for metal to rust when it is protected from the oxidizing effect of water by this thin but effectual covering of graphite.

A very interesting use of Aquadag as a lubricating material is to be found in its now general use for lubricating tungsten wire as drawn through a diamond die for the making of lamp filaments. Previous to the use of Aquadag for this purpose all tungsten filaments were of a wavy character, due, it is thought, to the slight friction in the die.

Many and valuable uses are found for graphite in the industries. Some of them, especially that of lubrication, are of commanding importance not only because of their intrinsic merit but also because of the office they fill in bringing about economy of other lubricants, saving oil and diminishing a serious problem which confronts the constantly increasing army of machine users. This is the Machine Age and consequently an age when the demand for lubricants shows constant increase. Graphite forms the line of least resistance in filling this demand — graphite artificially produced and 100 per cent efficient, in the form of Oildag and Aquadag.

The genius of Dr. Acheson has served his age and its industries in most liberal degree. His patents in the United States number fifty or more, and there are many more in the other industrial countries of the world. For the production of Oildag and Aquadag a separate company, the Acheson Oildag Company, was organized, by which a great business has been built up, with a plant located at Port Huron, Mich.

The business success of Dr. Acheson has been very great, but his most substantial reward comes from the assured benefit which industry and progress have reaped from his skillful labors. Both in chemistry and in electricity his labors have placed his name in the list of those who have wrought most ably through the wizardry of scientific endeavor. Recognition of his scientific scholarship came to him in 1909 by the conferring upon him of the honorary degree of Doctor of Science by the University of Pittsburgh. Commercial recognition has brought tangible rewards of much value, but far more significant of merit of purpose and achievement are the honors that have been conferred up him by scientific men and societies. To American chemists no mark of honor is more strongly desired than the Perkin Gold Medal, which is annually awarded, by its terms, "to the American chemist who has accomplished the most valuable work in applied chemistry during his career." These requirements of achievement are validated most strongly by the method prescribed by the bequest for the selection of the beneficiary. This duty is placed in the hands of a jury, made up of representatives of the various chemical societies of the United States; and for this reason the award of the Society's decoration, which was made to Dr. Acheson on January 21, 1910, is recognized as an expression, by the highest authority of the chemical profession, of the adjudicated value of the work of the recipient, as well as a rating of his personal distinction as a chemist. The

American Academy of Arts and Sciences also honored Dr. Acheson, in 1907, by its award to him of the Rumford Medal, "in recognition of his applications of heat in electrical furnaces for industrial interest." The John Scott Medal, which is awarded each year by careful selection on the basis of especially meritorious scientific achievement, has twice been awarded to Dr. Acheson by the Franklin Institute.

From the commercial side, also, Dr. Acheson has been singled out for distinction, the Paris Exposition of 1900 and the Louisiana Purchase Exposition at St. Louis in 1904 both having awarded Grand Prizes to him for the novelty and merit of his contributions to science and industry.

As electrical engineer, chemist and broad scientist Dr. Acheson is affiliated with and welcomed by many societies. He is a member of the American Institute of Electrical Engineers, the Franklin Institute of Philadelphia, the Society of Arts of London, the American Electrochemical Society, American Chemical Society, and the American Institute of Chemical Engineers (in which he has served as Vice-President), and he is a fellow of the American Association for the Advancement of Science. He is a member of the Chamber of Commerce of the State of New York, the University Club of Washington, Buffalo Club of Buffalo, and Niagara Club of Niagara Falls, and Engineers Club, New York.

Dr. Acheson tells an interesting incident of how he came to produce an absolutely pure carbon for Sir William Crookes, the eminent English scientist. It is as follows:

"While in London, England, in the latter part of 1911 Sir William asked me how pure I had ever made carbon, and I replied that my Company was placing graphite on the market in a commercial manner having a purity of 99.85, but that I believed I had probably gone, in some instances, as far as 99.95. Sir William replied that that was not at all pure, and farther, that he had never seen the spectrum of pure carbon. He stated he had carbonized refined white sugar, examined the spectrum of the carbon and found rays of iron, and in fact, he had never seen any carbon spectrum without iron in it. I told him that I expected almost immediately to return to America and I would endeavor to make and send to him a sample of pure carbon.

"On returning to America that winter, I had experimental work carried on by my engineers, and a sample of carbon was sent to Sir William Crookes in London. That winter, taking a trip through the Mediterannean, going up through Europe, I arrived in London in the spring of 1912, and on meeting Sir William Crookes, he advised me that he had received the carbon, and upon examination it was found to be absolutely pure.

"The fact of having produced pure carbon has not, to my knowledge, been published. However, during 1912 I was a guest at a dinner of the Royal Society Club at which Sir William Crookes preided, and before the gentlemen present, he related the foregoing incidents and advised the assembled company that the carbon was absolutely pure.

"This feat of purification of carbon demonstrated absolutely that all the elements present in my furnace mixture, where we find iron, silica, alumina and various other elementary bodies, are vaporized and may be driven off previous to the volatilization of the carbon."

Dr. Acheson's career has been made by his own efforts and genius. The beginnings of his upward journey were beset by handicaps, but he made his way by sincere earnestness as a seeker of physical truth, intelligent zeal for mastery of electrical and chemical science, his untiring industry, his patience in experiment and determined attack of every baffling problem. These characteristics mark him as one whose honors have been fitly won.

EDWARD D. ADAMS

EDWARD DEAN ADAMS

Although prominently identified for the last fifty years with other branches of financial, industrial and social activity, Mr. Adams has in many respects a claim to special recognition in these annals of electrical development in America. This is due partly to a native love of science and definite training as an engineer, whence sprang his ceaseless interest in electrical discovery and application, and such creative successful work as that which has left its imprint forever on the utilization of the energy of Niagara. But it is admittedly quite rare for the man of scientific culture and of engineering bent to win also control and direction of the financial resources adequate to the prosecution of great enterprises.

Edward D. Adams is essentially a product of New England. One of his direct ancestors fought at the battle of Bunker Hill. Born of Adoniram Judson and Harriet Lincoln Norton at Boston, April 9, 1846, he became a student at Norwich University, Vermont, in 1861, receiving, in all, four degrees from his alma mater; and was also a student at the Massachusetts Institute of Technology in 1869. At "Tech," one of the special courses that he took was that in architecture under the celebrated William E. Ware, who later became Professor of Architecture at Columbia University, New York City. In after years Mr. Adams served as chairman of the Building Committee representing the subscribers to the capital employed in the construction of Madison Square Garden, when the details of architectural competition, selection of design and supervision of the contract for building the colossal pile on Madison Square were all left as a burden on his shoulders. It was fortunate, but unusual, to say the least, that he could bring to bear on this task the knowledge and enthusiasm of an expert in what was, for him, decidedly an avocation.

Another aspect of Mr. Adams' temperament and character is brought into view by the fact that after the graduation from Norwich University his father, who had the good, old-fashioned belief in travel as an item of liberal education, sent him abroad for fifteen months. From this trip dated an early acquaintance with the art and architecture of Europe. It also included a visit to the Holy Land, where one of his companions was the famous Bishop Whipple of Minnesota, by whom he was baptized in the River Jordan—an incident which is probably unique in the life of any New York banker.

Formative study and travel ended, Mr. Adams turned with alacrity to practical affairs. Beginning at the bottom of a career which was to have much to do with finance and economics, he put in four years, 1866-70, with T. J. Lee & Hill, Boston, stock-brokers, and this led on to his partnership from 1870 to 1878 in the banking house of Richardson, Hill & Company. His shifting from Boston to New York in 1878 may perhaps be regarded as one of the earliest symptoms of a tendency which since has been much more intensely manifested in making Manhattan Island the financial metropolis of the country. He was a partner from 1878 to 1893 in Winslow, Lanier & Company, a firm of bankers of more than national reputation, with connections running far beyond Wall Street. The work here was strenuous, bringing with it the first connection of a public nature with electrical promotion just at the moment when solid support was sorely needed for adventures in the new fields of electric light, electric power and electric transportation. From the vantage ground of a present capitalization and investment in these utilities of over ten billions, it is easy to look back complacently upon the vast achievement of an intervening twenty-five years; but it took high courage and keen insight to subscribe or underwrite even the modest sums of money then demanded passionately by "parent" companies whose pretensions, however just, were invariably in inverse ratio to their credit. Except, unfortunately, in hydro-electric development, those days of speculative hazard have gone by for the various utilities to which they gave birth.

To this pioneer period belongs the organization of the first Edison Lighting Company, with its headquarters opened in 1881 in the celebrated stately old mansion at 65 Fifth Avenue. Mr. Adams as a

"Sixty-Fiver" was one of those active in the introduction of the incandescent lamp, and a member of the initial board of directors in the early eighties. Not only were there many leading New Yorkers in that memorable group of men at "65," but several whose rank in the profession has been attested by their presidency of the American Institute of Electrical Engineers. With 1893 began the connection of Mr. Adams with the Deutsche Bank as its American representative, this lasting until 1914. One of the incidents of that relationship with Germany was the breakfast given in New York by Mr. Adams in association with one hundred American "captains of industry" to Prince Henry of Prussia in 1908, at the time of his tour of the United States. In 1909 Mr. Adams was decorated with the Royal Order of the Crown of Prussia, Second Class, while in 1914 he was made by Harvard College chairman of the Committee to Visit the Germanic Museum, an institution owing its origin to the visit of the Prince. He was also president of the Germanistic Society of America in 1909 and a director in 1911. Mr. Adams also found himself concerned frequently in the interchange between Germany and America of electrical patents and processes.

Banking in America long found in railroads its chief preoccupation, and it was inevitable that Mr. Adams should have much to do with railroad management, operation, or financing. He was chairman of the finance committee of the Central Railroad of New Jersey, 1887-1894 and prepared and supervised the execution of the plan of reorganization without foreclosure; but undoubtedly the heaviest load of responsibility came when as chairman of the Northern Pacific Railroad Company reorganization committee, 1893-1896, he devised and carried out the plan of reorganization that rehabilitated the splendid property by means of which Henry Villard had opened up the great Northwest. At this time Mr. Adams was president of the Northern Pacific Terminal Company of Oregon as well as president of the St. Paul and Northern Pacific Railroad Company, and chairman of the Board of Directors of the reorganized Northern Pacific Railway Co. His railway directorships have included the Northern Pacific, Missouri Pacific, Denver & Rio Grande, West Shore and St. Louis, Iron Mountain & Southern, and the Western Maryland systems. During the decade 1890-1900, he was also president of the Chicago Terminal Transfer Railroad Company and the Niagara Junction Railroad Company. Although it is not generally known, Mr. Adams in the happier days of Mexico had much to do with the construction of railroads in that Republic, having been a concessionaire in the Sonora project and associated with Mr. Thomas Nickerson in the Mexican Central enterprise. About that time, incidentally, he became further interested in Mexico under a contract for the operation of two of the important mints of the country.

The broad idea of the utilization of Niagara is by no means new. As early as 1725, while its thick woods of pine and oak were still haunted by the stealthy redskin, a miniature sawmill was set up amid the roaring waters. The first systematic effort at "conservation" in harnessing Niagara was not made until nearly 150 years later, when the present hydraulic canal was dug, bisecting the town of Niagara Falls in a rather inconvenient way, and the mills were set up which disfigure the banks of the River just below the bridge that frames in the mighty cataract. Draining 300,000 square miles and with 90,000 square miles of reservoir area in the Lakes, this Atlantic set on edge has an average overspill of about 275,000 cubic feet per second. The quantity of water passing is estimated as high as 100,000,000 tons per hour. It was long obvious that the time-honored surface canal system would never answer for the proper utilization of the illimitable energy thus awaiting use, nor lend itself to the purposes of long distance power transmission. Many fantastic schemes were advanced for using and transmitting the 7,000,000 horsepower credited to Niagara by Professor Unwin, but it was Thomas Evershed, an American civil engineer, who devised the acceptable plan of diverting a part of the stream at a considerable distance above the Falls so that no natural beauty would be spoiled, while an enormous amount of energy could be obtained with a very slight reduction in the volume of water plunging

ever in rainbow glory and clouds of spray over the crest of the Falls. To the realization of this plan, electricity lent itself ideally, especially as the introduction of the alternating current had shown that far-flung circuits could economically deliver the energy hundreds of miles from the generating source.

Fortunately the problems of railroad direction and the influential steering of various manufacturing plants had by no means used up all of Mr. Adams' own supply of energy. The utilization of Niagara may almost be said to have been an obsession with him, and now with the needed engineering resources at his disposal he went boldly and cautiously forward. His associates on the one hand were some of the leading capitalists and lawyers of this country, to whose judgment was added that of the International Niagara Commission, embracing such men as Lord Kelvin, Mascart, Coleman Sellers, Turrettini and Unwin. As a result of the thought and experience brought to bear on the subject, a perfected and concentrated Evershed scheme was put into effect about 1¾ miles away from the Falls, far beyond the outlying Three Sisters Islands whose reefs oppose the first barrier steps to the gliding river before its headlong leap into the chasm. The plan adopted comprised a short surface canal for intake to a massive power house designed by Stanford White, in which were installed five huge generators of Westinghouse make, embodying the two-phase inventions of Nikola Tesla. From the dynamos, shafts extended downward nearly 150 feet to the turbines at the bottom of the wheel pit, from which the fallen water discharged itself to the lower river, through over a mile of tunnel, in a minor Niagara of its own, having still a velocity of 20 miles an hour. The enterprise required an expenditure of several million dollars, but the investment was soon justified. The plant was duplicated both on the American side and in Canada by the Niagara Falls Power Company, while several other plants have since come in to help mitigate the cruel waste of energy that has gone on for so many ages. It is of the highest encouragement to conservationists, in the contemplation of the crying need for energy in the forms of light, heat, power and traction, to know that, as an example, Niagara has thus been carried eastward to Toronto, westward to Buffalo, Rochester and Syracuse, and has within its beneficent reach in the Dominion a large part of the Province of Ontario. In June, 1917, Mr. Adams declined the presidency of the Niagara Falls Power Company, on the score of the multiplicity of other duties.

That such a plea might reasonably be offered is evidenced by the fact that Mr. Adams has for the last quarter of a century been busy also with the affairs of numerous industrial and manufacturing concerns of importance, as president, vice-president or director. The list is an extraordinarily long one, some items being the Allis-Chalmers Company, Bullock Electric Manufacturing Company, Central and South American Telegraph Company, American Cotton Oil Company, Davis Coal & Coke Company, Lehigh Coke Company, Empire Engineering Corporation, International Typesetting Machine Company, Intertype Corporation, Kerbaugh-Empire Company, East Jersey Water Company, N. K. Fairbanks Company, Elkhorn Corporation, Union Petroleum Company of Philadelphia, Hammond Typewriter Company, Clinchfield Corporation, New Jersey General Security Company, Mohawk Hydro-Electric Company, Rumson Improvement Company. The "diversity factor" certainly looms up large.

Of far too catholic a disposition to be absorbed in a business career, Mr. Adams has given play to his artistic tastes and public spirit in a variety of directions, touching life very inclusively and fully in all its higher social aspects. The magnificent Metropolitan Museum of Art has been preeminently one of his beneficiaries in gifts and service, through the Board of Trustees, the Committees on Finance, Executive, Buildings, Casts and Reproductions, Educational Work, Library, Sculpture, and more lately the special J. Pierpont Morgan Memorial Committee. In like manner the New York Botanical Garden has enjoyed his close official attention, with the Institute of Musical Art of the City of New York, the Kahn Foundation for the Foreign Travel of American

Teachers, the Grant Monument Association, the American Academy in Rome, and the American Scenic and Historic Preservation Society. A keen love of coins for other than their metallic values is seen in his deep interest in the American Numismatic Society, of which he has been elected an Honorary Member for life. Through many years he served the Society with pleasure as chairman of the Committee on the Publication of Medals, inaugurating during that time the striking of a series of historical medals pertaining particularly to the early history of this country. At the other end of the scale it may be noted that Mr. Adams is vice-chairman of the Engineering Foundation Board in the United Engineering Society, on whose Library Board he is a representative on behalf of the American Institute of Electrical Engineers. These are nevertheless but instances and examples from a list of memberships in some thirty social Clubs and nearly sixty Societies, Academies and Associations.

A resident of New York, Mr. Adams has his summer home, "Rohallion," at Rumson, New Jersey, where he is naturally president of the Country Club and the Improvement Company, vice-president of the Monmouth County Agricultural Fair Association, vice-president and director of the Monmouth County Historical Association and senior warden vestryman and trustee of the Endowment Fund of the Episcopal church of St. Georges-by-the-River.

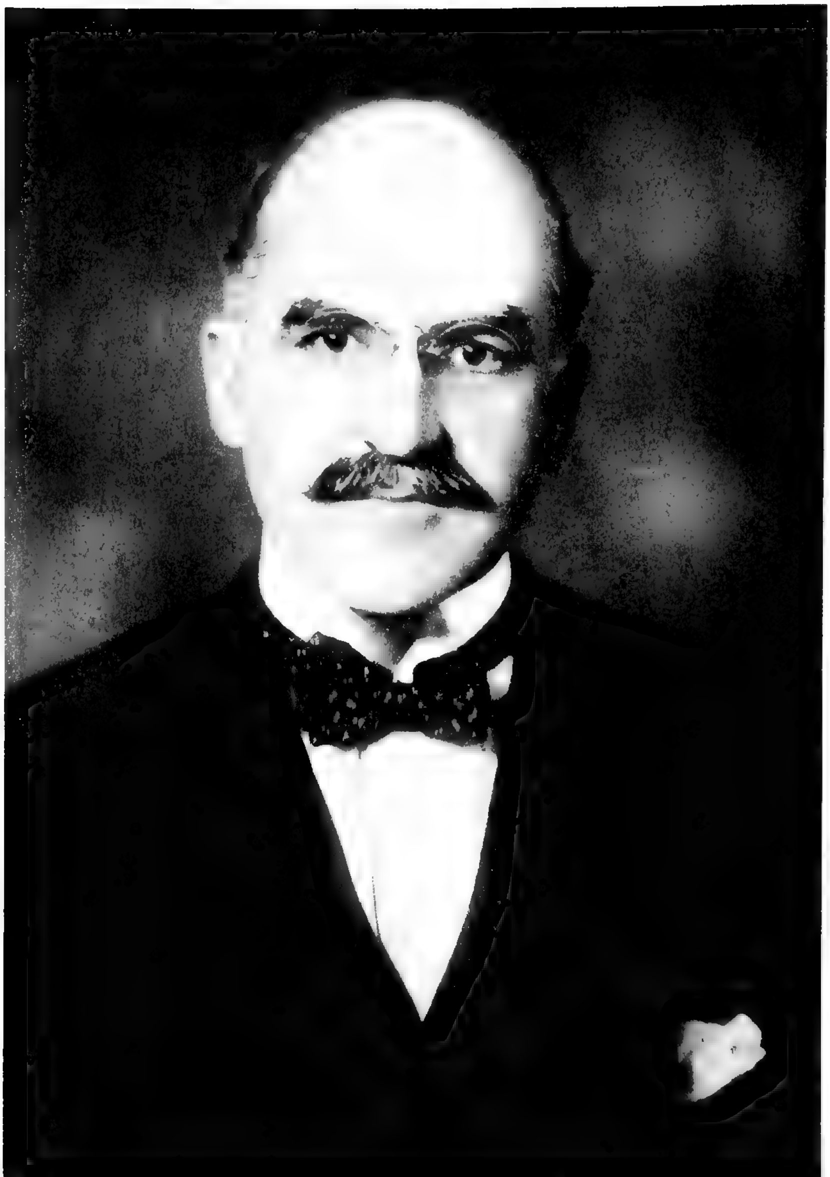
In 1872, Mr. Adams married Miss Frances Amelia Gutterson of Boston, by whom he has had two sons and a daughter. One of the sons died in childhood. The other, Ernest Kempton Adams, deceased in his thirtieth year, was an investigator and engineer of most unusual promise, the record of whose researches and inventions chiefly in electricity fills two large volumes. To his memory as a graduate of Columbia, The Ernest Kempton Adams Fund for Physical Research and the Precision Laboratory of the same title have been established in the University, to which endowment may already be attributed the publication of several valuable lectures and monographs in the domain of physics.

ALDRED & COMPANY

In connection with the electrical development of recent years, one of the outstanding features is the growth in the use of electric energy generated by water power. The first development on a large scale was that of Niagara Falls, U. S., to be closely followed by the installation of an extensive plant and transmission facilities at Shawinigan Falls, P. Q. The success which attended these initial enterprises gave an impetus to further development, as indicated by the large works which have since been carried out, such as the Ontario Power Company, of Niagara Falls; Montana Power Company, Pennsylvania Water & Power Company, Cedars Rapids Manufacturing & Power Company, Kaministiquia Power Company, Adirondack Electric Power Corporation, Mississippi River Power Company, and Laurentide Power Company, the aggregate of which amounts to 1,216,000 H.P., all of which is distributed in the form of electricity over the areas of operation covered by these companies. It may be said that this contribution to the development of electricity has largely taken the form of a stimulating influence in the use of power for a great variety of uses in the territory in which the companies operate. The result has been to largely increase the use of electricity in those sections as compared with other sections dependent upon current furnished from steam plants. Even where steam operation was essential for the carrying of a part of the load, these situations have been stimulated to an exceptional degree by the introduction of hydro-electric plants capable of carrying a part of the load.

A phase of this development is that, while at the outset it was generally considered that power from a hydro-electric plant was in respect of continuity not of the same class as steam generated power from a central station, this prejudice against the energy purchased from hydro-electric sources has entirely disappeared, as the records show that cities depending entirely on their supply of energy from hydro-electric sources have been quite as free from interruption as other cities depending on steam plants.

The problem of making hydro-electric installations financially successful has been



JOHN E. ALDRED

solved through the development of a high load factor, resulting in many cases from a creation of a diversity factor in respect of the use of power. In considering future projects where this high load factor can be assured in advance, it will make possible the carrying out of hydro-electric enterprises, which, through lack of this factor, would have been impossible ten years ago.

In the carrying out of extensive hydro-electric developments, the storage of water to supplement the normal flow of rivers will more and more figure as of importance in the undertaking. While we hear a great deal in the United States in regard to conservation, we need to go outside of this country to witness the most intelligent application of this principle to the preservation and development of the natural resources of a country. On the continent of Europe for many years the waters of streams available for power purposes have been carefully controlled and regulated. On this continent the outstanding work of this character is that being carried on in the Province of Quebec, Canada, where, under a plan fostered and developed by the Provincial Government, extensive storage basins have been created in some of the more important rivers utilized for power purposes.

The La Loutre Dam recently completed in the headwaters of the St. Maurice River, on which are located the great hydro-electric works of the Shawinigan Water & Power Company, and the Laurentide Power Company, Ltd., furnishes the finest example extant of the conservation of water resources for regulation purposes. This dam is capable of storing 160,000,000 cubic feet of water available for the purpose of increasing the flow of the St. Maurice River. It was built and paid for by the Provincial Government of Quebec, charges being made against the existing power companies operating on the river, which annual charges are sufficient to cover the interest on the cost, operation of the plant and a sinking fund.

This enterprise will be an important economic factor in the development of the Province of Quebec. When we consider the lack of regulation of the flow of the important rivers in the United States and the damage that results therefrom, it is difficult to understand why in all these years there has been no substantial attempt made to improve conditions. Now that the way has been pointed out by the Government of the Province of Quebec, we may hope that in time an appreciation of the desirability of similar work will lead to the carrying out of projects akin to that referred to above.

At this time, when consideration is being given to legislation intended to facilitate the development of water power resources of the country, it is important to keep in mind the lessons we have learned from carrying out many of the large hydro-electric works above mentioned.

First should be dispelled the erroneous impression in the minds of those who have at times given public utterances to their thoughts on this subject and have stated that these enterprises have resulted in extraordinary profit. This thought has its birth, as many similar expressions of opinion, in the idea that anything based on the use of natural resources and in any sense involving public ownership of property, *must* be profitable. As a matter of fact, those familiar with the large operations so far undertaken, know only too well that the financial results obtained have, on the whole, been disappointing and have demonstrated that the carrying out of these large hydro-electric developments may be properly termed an extra hazardous undertaking. This must in some degree always be so, as one deals with natural conditions, and it is never possible to anticipate all of the contingencies involved in an undertaking which must deal with conditions that cannot be entirely forestalled.

That these developments have been carried out during years of experimental exploitation, both in respect of water wheel efficiency, electric generator efficiency and efficiency of transmission systems, and this development stage has necessarily involved extraordinary expense, holds out the hope that future essays of this kind will benefit accordingly what has thus gone before.

In view of these facts, the obtaining of the necessary capital in the future to carry out large water power developments will depend primarily upon the restrictions imposed upon the enterprise by the legislation

now under consideration in Washington. It will be necessary not only to avoid restrictive conditions which will prevent capital from winning a return comparable with that offered by other forms of enterprise, but inasmuch as this is a comparatively new field of investment for capital, it will be necessary to hold out extra inducements to tempt large amounts of investment capital.

In Mr. Aldred's opinion, if the bill now before the House in Washington, January, 1918, contains clauses which do not harmonize with these requirements, it will not only fail to accomplish the purpose for which the bill is intended, but will paralyze the development of power enterprises for many years. The one most desirable thing in any business enterprise is to get that cumulative benefit which comes through good management and building up credit. If this is to count for nothing at the end of the game, the proposition is hopeless and will not in any sense be inviting to capital.

JOHN E. ALDRED

Senior Member of Aldred & Company and a Prominent Figure in the Hydro-Electric Field

One of the prominent figures in the development of hydro-electric power is J. E. Aldred, senior member of the firm of Aldred & Company, 24 Exchange Place, New York City, whose success has been phenomenal since he entered the field. Mr. Aldred was born May 5, 1864, in Lawrence, Massachusetts, and was educated in the city of his birth. His first entry into commercial affairs was with the Pacific Mills, which manufactured textiles exclusively, and shortly afterwards, with no previous knowledge of financial affairs, he moved to Boston, where he entered the banking business. Here his executive talent and power of organization found a field for display, and in 1896 he organized the Puritan Trust Company. Three years later he transferred his power of organization to Canada and formed the Shawinigan Water & Power Company of Montreal, which is the largest water power company in the world.

This was the beginning of his large activities in the hydro-electric field, and since that time he has organized and developed many important corporations of a like character throughout Canada and the United States. Among the companies in which Mr. Aldred has been actively interested are the Montreal Light, Heat & Power Company, the Cedars Rapids Manufacturing & Power Company and the Laurentide Power Company, Ltd. He also took over the moribund McCall Ferry Power Company, on the Susquehanna River, which he converted into the Pennsylvania Water & Power Company. This company is now the principal source of supply of electrical energy to the City of Baltimore, and its acquisition by Mr. Aldred was the forerunner of many activities in the southern city.

He made an industrial survey of Baltimore, which was the first ever made of a city, and led in the movement to stimulate industrial development there. This brought about the erection of many plants, among which was a tin plate mill, built by Mr. Aldred and afterwards sold to the Bethlehem Steel Company. In 1910 Mr. Aldred acquired control of the Consolidated Gas, Electric Light & Power Company, of Baltimore. In 1913 he organized the firm of Aldred & Company, which acts as fiscal agents for these and several other companies. The other members of the firm are R. M. Smith, Morton Otis and F. C. Nichols.

Mr. Aldred is a member of the Nassau and Piping Rock Club, on Long Island; the St. James Club, of Montreal, and the Maryland Club, of Baltimore. He resides at Locust Valley, Long Island.

COMFORT A. ADAMS

Professor Comfort A. Adams of Cambridge, Mass., elected to the presidency of the American Institute of Electrical Engineers in 1918, is one of New England's most learned teachers of the electrical science. He is also engaged in private practice, and has attained the highest reputation as an engineer. Professor Adams was born in Cleveland, Ohio, November 1, 1868, the son of Comfort Avery and Katherine Emily (Peticolas) Adams. He was educated at the Case School of Applied Science, Cleveland, Ohio, from which he received the B.S. degree in 1890 and the degree of E.E. in 1895. He assisted in physics at the Case School previous to graduation and afterwards took a course in physics and mathe-

matics at Harvard University. He was engaged in engineering design in 1890-91 and in the latter year became an instructor in electrical engineering at Harvard. From 1896 until 1906 he was assistant professor, and professor of electrical engineeering from 1906 until 1914, when he became the Abbott and James Lawrence professor of engineering, a position he still occupies, assuming later a like position with the Massachusetts Institute of Technology. In his consulting practice he has numbered among his clients, Stone & Webster, and the American Tool and Machine Co. of Boston; the Warner Sugar Refining Co. of New York; the Simplex Wire & Cable Co. of Cambridge, Mass.; the Okonite Company of New York; the Boston Edison Company and the Public Service Electric Co. of New Jersey. He was a member of the international jury of awards (department of electricity) at the Louisiana Purchase Exposition, held at St. Louis in 1904. He is a member of the Engineers' Club of New York, a Fellow of the American Academy of Arts and Sciences, the American Association for the Advancement of Science, and of the American Institute of Electrical Engineers, being chairman of the Boston branch in 1905 and 1906. He also holds membership in the American Society of Mechanical Engineers, the Institute of Electrical Engineers, London; the Illuminating Engineering Society; Society for the Promotion of Engineering Education, American Physical Society; the National Electric Light Association; the Economic Club; the Harvard Club of Boston; the Harvard Union and the Oakley Country Club. He is Field Officer and Chairman of the Welding Committee of the U. S. Shipping Board Emergency Fleet Corporation, also Chairman of the Electrical Engineering Section of the National Research Council. He has been a liberal contributor of scientific papers to the technical press and is the author of "Dynamo Design Schedules". Much of Professor Adams' work has been along the lines of theory and research which has resulted in the contribution of many valuable discussions to engineering society meetings. Professor Adams was married June 21, 1894, to Elizabeth Challis Parsons of Greenfield, Mass., and has two children — John and Clayton Comfort Adams.

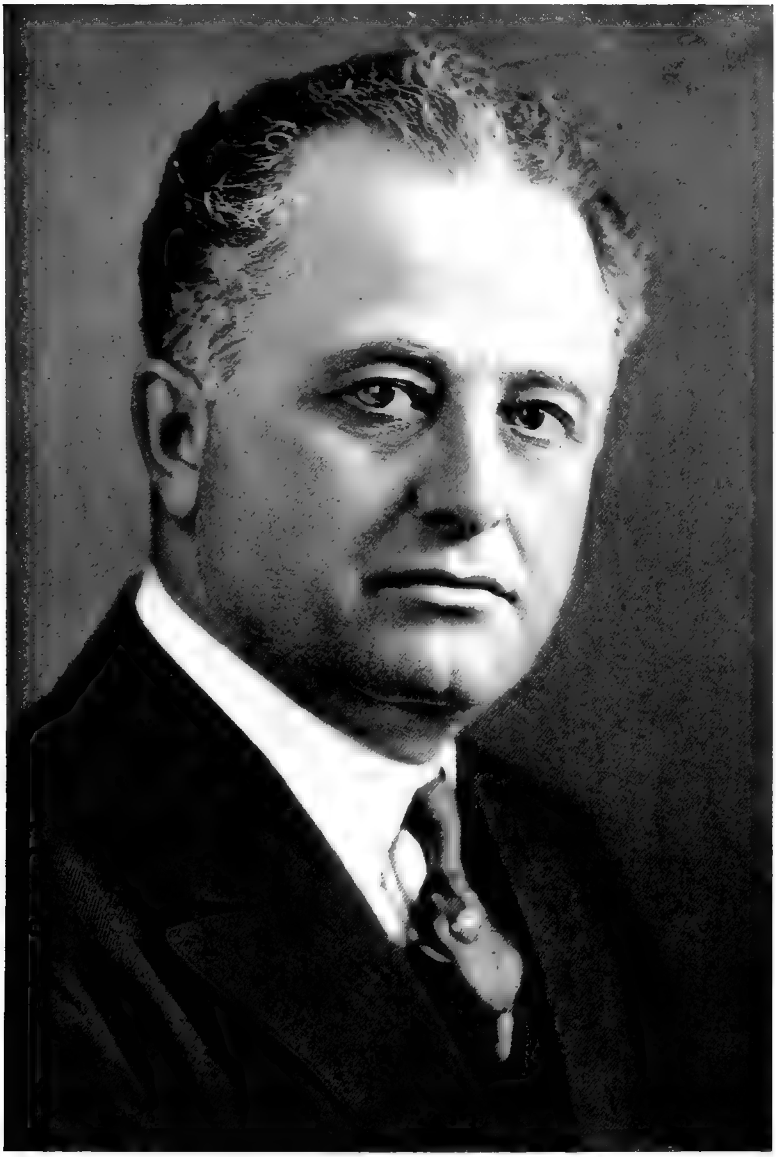
FRANCIS J. ADAMS

Professor Francis J. Adams of the Worcester Polytechnic Institute has specialized on the educational side of electrical activity and development, in which he has attained proficiency and high repute. He was born in Maynard, Massachusetts, December 8, 1880, and after having completed his elementary and preparatory education he entered the Worcester (Mass.) Polytechnic Institute, from which he was graduated in 1904, and was one of six men receiving the Salisbury prize and election to Tau Beta Pi and Sigma Xi.

He supplemented the knowledge gained in the courses and laboratories of the Worcester Polytechnic Institute with practical work in the employ of the Westinghouse Electric and Manufacturing Company, as engineer in the Transformer Division of the Engineering Department, and later with the Worcester Electric Light Company as assistant to the Superintendent of Distribution, and as assistant to the Superintendent of the Service Department in charge of investigations. He has thus gained a thorough knowledge of the working details and economic factors of the business of distribution and service as a valuable auxiliary of the technical mastery of the principles and practice of electrical engineering.

His teaching connection with the Worcester Polytechnic Institute began as a graduate assistant, and he was later advanced to instructor and from that to his present position as assistant professor of electrical engineering. In educational work he is able and convincing, adding to the advantage of a mind well stored with scientific and practical knowledge as learned from field and work shop, as well as from the lecture room and laboratory, the teaching gifts which enables him to impart his own knowledge to others.

In addition to his educational and professional occupations, Professor Adams has a predilection for the study and practice of photography. He is greatly interested in Masonry also, as a member of both the Scottish Rite and York Rite bodies.



HARRY ALEXANDER

Mr. Harry Alexander, mechanical and electrical engineer, has earned a place of prominence in connection with important electrical installations in the United States and abroad, and in many valuable ways in research, experiment and invention. He was born in New York City, August 6, 1871. He was educated in the public schools. A general interest in and enthusiasm for mechanics caused him to take up intensive private study of technical subjects, attending lectures and special courses, also reading most of the prominent and standard works on electrical and kindred subjects. He added practical training by working in various power houses for railroad companies and in machine shops. From 1886 to 1888 he was with the Daft Electric Light Company, of Greenville and Marion, New Jersey, and assistant in experimental operations with the "Benjamin Franklin" on the Ninth Avenue Elevated Railroad in New York City. In 1889 he entered the service of the

Thomson-Houston Electric Company at Lynn, Mass., where he was in charge of the testing department, and in the following year was general inspector for the Thomson-Houston Motor Company in the New England states. In the latter part of 1890 he was transferred to the Thomson-Van Depoele Mining Machine Company, in complete charge, at Dover, N. H., of building and designing electric mining machinery at the Somersworth Machine Shop. In 1891 Mr. Alexander went into business for himself as an industrial engineer in his own name. Later he organized the Alexander-Chamberlain Company, of which he was president and electrical engineer until it was merged into his private business, later designated as Harry Alexander, Incorporated. The home office of this company has continued to be in New York, with branch offices at different times in Washington, Pittsburgh, Baltimore, Boston and Rochester; and since 1910 the company has maintained a permanent branch office in Toronto for Canadian business. In 1893 Mr. Alexander was retained by L. F. W. Arend and others, of Buffalo, and in charge of the survey of the Lockport and Tonawanda Canal with view to the construction of a hydro-electric plant on Lake Ontario. The project fell through because its backers thought it a dream—since, however, a reality. In 1893 and 1894 Mr. Alexander designed and patented an underground trolley system, including separate systems for continuous live conductor and automatic sectional live conductor. In 1894 Mr. Alexander conducted extensive experiments at the Cheseborough Works in the precipitation of white lead by electrolysis. In the early part of 1895 he designed and in 1896 completed the entire Siegel-Cooper electrical plant, New York City of over one thousand kilowatts, with twenty-three electrical elevators and special electrical apparatus for various purposes. This was the largest isolated plant of that time, as well as the largest electric elevator plant. In 1900 he designed apparatus and was in charge of experimental work for a bleaching process by electrolysis, the company for which he did this work subsequently putting Electrozone on the market as a result of this experiment. In 1904 he was retained by Robert C. Hall and allied interests of Pittsburgh to investigate and report on the Pittsburgh electric light, power and street railway situation relative to combining power production for all interests. During the three years from 1906 to 1909 Mr. Alexander was largely engaged with railroad and other large construction work in mechanical and electrical engineering, being designing and contracting engineer for the Baltimore & Ohio R. R. office building in Baltimore in 1906 and after that contractor for the original East Side Terminals, New York Central Railroad, in connection with the new Grand Central Station, and in 1906-1907 he patented an interior conduit system and its detail devices. In 1909 he was contracting engineer for the sub-station and construction work for the United Railway of Havana, Cuba (sub-contract). In 1913 he was retained as supervising engineer for the May Department Stores Company, St. Louis, Missouri, for the entire electrical and mechanical equipment for their new building in connection with the Railway Exchange Building. Mr. Alexander has done a considerable amount of industrial work throughout the United States and Canada, Cuba and the Orient, involving a trip around the world in 1903. He was one of the early users of storage batteries for automobiles and for equalizing excessive loads in industrial plants. He is the inventor of many industrial devices and systems, such as the Alexalite, the pioneer indirect monolux unit, and he is president of the Alexalite Company. He is a member of the American Institute of Electrical Engineers, A. S. M. E., New York Electrical Society, Aeronautical Society, Engineers' Club, American Association for the Advancement of Science, American Geographical Society, Atlantic and Royal Canadian Yacht Clubs, Engineers' Club, of Toronto; Great Neck Golf Club, Metropolitan Museum of Art and Museum of Natural History.

Francis Blake.

FRANCIS BLAKE

The invention of the Blake Transmitter, with the notable advance it accomplished in the field of telephony, will always remain as the best known and most notable of the achievements of the fruitful, inventive genius of the late Francis Blake. But his career was rounded out by many useful labors that left their impress in permanent results.

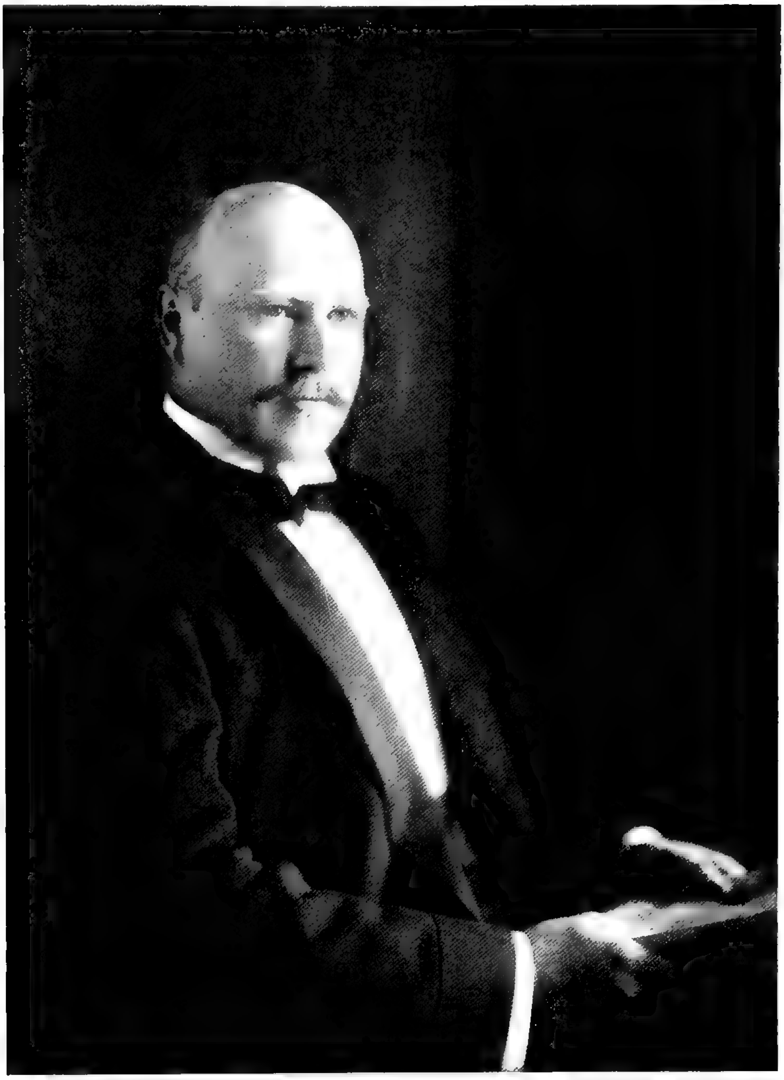
Mr. Blake was born December 25, 1850, in Needham, Massachusetts, son of Francis Blake, who was active in business life and who was for several years United States Appraiser of the Port of Boston, and of Caroline Burling (Trumbull) Blake of the prominent New England Trumbull family. In the paternal line Mr. Blake was descendant in the eighth generation from William and Agnes Blake, who emigrated to Massachusetts before 1636, and settled in that part of Dorchester now known as Milton. William Blake, the emigrant ancestor, became active and distinguished in Colonial affairs, and his descendants have been men of mark in Massachusetts. The Hon. Francis Blake, Mr. Blake's grandfather, was State Senator from Worcester and a prominent leader at the Worcester County Bar.

Mr. Blake was educated in the public schools until he left the Brookline High School in 1866, to enter the United States Coast Survey, to which his uncle, Commodore George S. Blake, U. S. N., had secured his appointment. He began with a hydrographic survey of the Susquehanna River, near Havre de Grace, Maryland, following with similar surveys on the west coast of Florida and north coast of Cuba. He was stationed at Harvard College Observatory in 1868, working on longitude determination between Cambridge and San Francisco, and in 1869 was stationed at Cedar Falls, Iowa, and St. Louis, Missouri, to determine the astronomical latitude and longitude of those places, following which he was promoted from aid to sub-assistant. In October, 1869, he went to Brest, France, and determined the astronomical difference of longitude between Cambridge, Mass., and Brest by means of time signals sent through the French Cables. In 1870 he was astronomer of the Darien Exploring Expedition (Commodore Selfridge, U. S. N., commanding) which examined the Atrato River and Tuyra River routes, with reference to possible ship canal construction across the Isthmus of Darien. Going to Europe in 1872, he assisted in the third and final determination of the differences of longitude between the Greenwich, Paris and Cambridge (Mass.) observatories, under Professor Julius E. Hilgard, and made observations in 1872 which gave a new result for the longitudinal difference between the Greenwich and Paris observatories. Mr. Blake returned in 1872 and was stationed at the Harvard Observatory. He represented the Coast Survey at a Conference of the New York and Pennsylvania Boundary Commission in 1875, and later was on a survey of Boston Harbor.

Mr. Blake resigned from the Coast Survey in 1878. From this research and experiment came the famous Blake Transmitter, which is recognized as one of the most vital factors of improvement in telephony. Mr. Blake continued his interest in electrical research, and was granted twenty patents in twelve years. He was a director of the American Telephone and Telegraph Company from 1878. Harvard University conferred upon him the honorary degree of A.M. in 1902.

He was a fellow of the American Association for the Advancement of Science and of the American Academy of Arts and Sciences; member of the Corporation of the Massachusetts Institute of Technology from 1889; member of the National Conference of Electricians, 1884, American Institute of Electrical Engineers, life member of the National Geographic Society, fellow of the American Geographical Society; member of the Bostonian Society, the Boston Society of the Archaeological Institute of America, and the Somerset and Union Clubs; honorary member of the Telephone Pioneers of America.

Mr. Blake died at his home in Weston, Mass., January 19, 1913, leaving as survivors his wife, Elizabeth L. (daughter of Charles T. Hubbard), whom he married June 24, 1873, and their two children, Agnes and Benjamin Sewall Blake.



CHARLES F. BANCROFT

Charles F. Bancroft, electrical engineer, born at Mansonville, Quebec, Canada, December 17, 1873, attended Knowlton Academy and St. Johns School, Montreal.

His uncle, F. S. Smithers, a director of the Edison General Electric Company, secured him admission, in 1890, to the students' course which that company had just inaugurated, and which he completed in 1893.

He had charge of the testing department of the Royal Electric Company, Montreal, 1893-1894; was electrical engineer of the Lowell and Suburban Street Railway, Lowell, Massachusetts, 1894-1900; since then electrical engineer of the Massachusetts Electric Companies; also since 1912 vice-president of the Manchester Electric Company, and since 1905 superintendent of motive power of the Bay State Street Railway Company.

He is a fellow of the American Institute of Electrical Engineers, member American Society of Mechanical Engineers, Boston Chamber of Commerce, Engineers' Club (New York), and life member Engineers' Club (Boston). He married, on June 7, 1905, Cornelia H. Dow, of Brooklyn, New York, and they have two children.

H. M. BYLLESBY

H. M. BYLLESBY & CO.

BY W. H. HODGE.

Henry Marison Byllesby identified himself with the electrical industry at its practical inception in the United States. During a long and active career he has won a prominent place as an engineer, organizer, financier, constructor and operator. For years the house bearing his name has ranked among the larger and more progressive public utility organizations of the country.

Mr. Byllesby, from the first month of the great war, devoted much time to the interest of the Entente Allies. He was one of the few men who, from the beginning of the war, correctly visualized the tremendous issues involved and with extraordinary intuition appreciated the situation of the United States in the struggle. From August, 1914, until the entrance of the United States into the conflict, Mr. Byllesby was very active in platform and organization work and, beginning April 6, 1917, he gave his entire time to the service of the Nation. As Chairman of the Executive Committee of the Chicago Branch of the National Security League, Mr. Byllesby was primarily responsible for the inauguration of the great patriotic speaking campaign in the West and Central Northwest which was opened at Minneapolis September, 1917, with Samuel Gompers and Clarence Darrow as principal orators. This was followed by great mass meetings at Chicago and elsewhere with Elihu Root, Theodore Roosevelt, William Howard Taft, former Ambassador Gerard, Reverend Doctor Hillis, T. P. O'Connor, Samuel Gompers and other prominent men as speakers.

As the result of earnest solicitation by the War Department, Mr. Byllesby accepted a commission as Major in the recruiting division of the United States Signal Corps November 15, 1917. He has since been active as an officer of the United States Army, and at present (June, 1918), is Lieutenant-Colonel on overseas duty.

Mr. Byllesby was born at Pittsburgh February 16, 1859. His father, Rev. DeWitt Clinton Byllesby, was a clergyman in the Protestant Episcopal Church. Originally of English ancestry, Mr. Byllesby's American lineage on the side of his mother, Sarah Mathews, dates to 1620 and on his father's side to 1789.

His education was received at the Western University of Pennsylvania at Pittsburgh, where he took a preparatory course, 1871-73, and at Lehigh University, 1873-1877, where he studied the course in

ARTHUR S. HUEY
Vice-President in Charge of Operation

Mechanical Engineering. He was not graduated, leaving at the end of the junior year to work in the laboratory and machine shop of the Weston Dynamo and Electric Machine Company, at Newark, New Jersey. Mr. Byllesby's application to the practical affairs of life began earlier, however, as he was employed during vacations, beginning at the age of twelve years, in machine shops at Allentown, Pennsylvania, and later in the general ticket office of the Central Railroad Company of New Jersey.

In November, 1879, he entered the drawing office of Robert Wetherill & Company, manufacturers of Corliss engines and mill machinery, at Chester, Pennsylvania, remaining with them until June 1, 1881. On that date his direct connection with the electrical industry began in the service of The Edison Company for Isolated Light-

ing, at 65 Fifth Avenue, New York City. After a few months as draftsman he was made the Draftsman of the First District Pearl Street Station of the original Edison Electric Illuminating Company of New York, serving under Mr. C. L. Clarke, Chief Engineer, and his assistant. Under their immediate direction Mr. Byllesby made all of the drawings for the structure, cranes, location of boilers, engines and switchboards of this, the first steam operated central station in the United States. During the same period he also made drawings for central stations near Valparaiso, Chile.

In November, 1882, Mr. Byllesby was sent by the Edison Company to Canada to manufacture dynamos and certain other patented devices for a cotton mill installation at Cornwall, Ontario. He remained in Canada until July 1, 1884, and during the interval secured contracts for several other cotton mill installations, for the installation of three steamships of the Canadian Pacific Railway on the Great Lakes and for several sugar refineries. He directed the manufacture of the dynamos and other patented apparatus as well as supervising their installation.

From August 1, 1884, to February 1, 1885, he was on the general engineering staff of the Edison Company, and during that period had charge of the mechanical engineering and subsequent operation of electrical installations for lighting the exhibitions at Louisville, St. Louis and New Orleans.

Leaving the Edison Company in 1885, Mr. Byllesby was the Eastern Manager, resident in New York, of Robert Wetherill & Company for about ten months. November 1st of that year he became associated with the late George Westinghouse, who then controlled the Union Switch and Signal Company and had become interested also in electric lighting, conducting his electrical interests as a personal venture. Mr. Westinghouse had enlisted the services of the late William Stanley, Jr., the late O. B. Shallenberger and Albert B. Schmid, and had started the making of electrical apparatus in the works of the Union Switch and Signal Company, Garrison Alley, Pittsburgh.

Soon after this connection the Westinghouse Electric Company was formed, with Mr. Byllesby as Vice-President and General Manager. Mr. Westinghouse had previously purchased the alternating current patents of Goulard and Gibbs, and experiments were being conducted toward perfecting and commercializing the principle. Mr. Byllesby vigorously appre-

OTTO E. OSTHOFF
Vice-President and Chief Engineer

ciated the possibilities of alternating current transmission and, in company with Messrs. Westinghouse, Stanley, Shallenberger, Schmid and Philip Lange, work was carried forward which produced in the early Fall of 1886 the first commercial alternating current electric lighting apparatus.

The business of the company thenceforth grew rapidly, sales were heavy, and before the end of the year the company bought the works of the Union Switch and Signal Company and greatly enlarged them. Mr. Byllesby at this time was very active in the engineering and mechanical development of the industry in addition to broad duties of a commercial nature, taking out, either in his own name or as an associate inventor, approximately forty

patents of various details of electric lighting apparatus and systems.

From May 1, 1889, to September 1, 1891, Mr. Byllesby spent most of his time in Europe representing the Westinghouse Electric Company in its early enterprises in connection with the development of foreign business. He resigned from the company in December, 1891, owing as stated "to personal differences with Mr. George Westinghouse growing out of a wide divergence of views as to the financial affairs of the company."

February 1, 1891, he became associated with the Thomson-Houston Electric Company interests, and on April 1st of that year became the President of the Northwest Thomson-Houston Company. This was a subsidiary organization to the parent company, with headquarters at St. Paul, having the exclusive business of the company in northern Wisconsin, North Dakota, South Dakota, Montana, Idaho, Washington and Oregon. He remained as President of this organization and its successor, the Northwest General Electric Company, until the Spring of 1895, when the company went out of existence, having been absorbed by the General Electric Company.

From the Spring of 1895 until January 1, 1902, Mr. Byllesby was actively engaged on various enterprises, principally of his own creation, and the majority having to do with the construction of some of the earlier water powers developed in the United States. From 1891 to 1894 he was Vice-President of the Portland (Oregon) General Electric Company, and was prominently identified with the designing, building and financing of the original water power on the Willamette River at Oregon City. During the period from 1894 to 1898 he was active in Montana, personally exploring the entire water power situation in Central Montana, constructing two initial hydro-electric developments and laying out the plans in detail which were followed in the subsequent development of the Montana Power Company.

In the course of his work in Montana Mr. Byllesby personally financed and was directly in charge of the construction of the water power development in the Big Hole River, twenty miles south of Butte. This was a rather unique and fair-sized development for those days, having an installed capacity of 4,000 horsepower, and involving the construction of reservoirs thirty miles up stream. Another enterprise was the building of a water power on the Big Blackfoot River and transmitting electricity seven miles to the city of Missoula.

JOHN J. O'BRIEN
Vice-President and Treasurer

This plant of 2,000 horsepower proved highly successful, both in operating results and financial returns.

He, also in these years, made exhaustive examinations of other water powers, among them being the great works which the government is developing at the outlet of Flathead Lake in Montana, and water powers in northern Minnesota, including the properties of the Great Northern Power Company near Duluth, for which he served in an advisory capacity for nearly every feature of the construction.

Subsequently he was associated with the Washington (D. C.) Light and Traction Company, with the Riker Motor Vehicle Company, and with the Electric Vehicle Company.

January 1, 1902, he established in Chicago the organization of H. M. Byllesby

& Company (Incorporated), of which he has always been President.

Established primarily as an engineering concern, the activities of H. M. Byllesby & Company soon acquired a much broader scope and within a few years the firm became prominent in the financing, designing, construction, operation and management of electric light and power, gas and street railway companies. A staff was gathered and maintained of experts in all phases of public utility administration—engineering, construction, finance, legal, operation, commercial, publicity, etc. Utility properties were purchased, reorganized, financed, rebuilt and extended and conducted on modern lines, both from the standpoints of efficiency and business ethics. Properties were grouped and linked together for economical and better operation. Vigorous methods were employed to extend service over the widest practicable limits and to build up the business. The problem of public relations was studied with unwearied attention, with results widely known and commended.

In 1918 H. M. Byllesby & Company were responsible for growing utility companies serving about 2,000,000 people in upwards of 400 communities scattered throughout sixteen states.

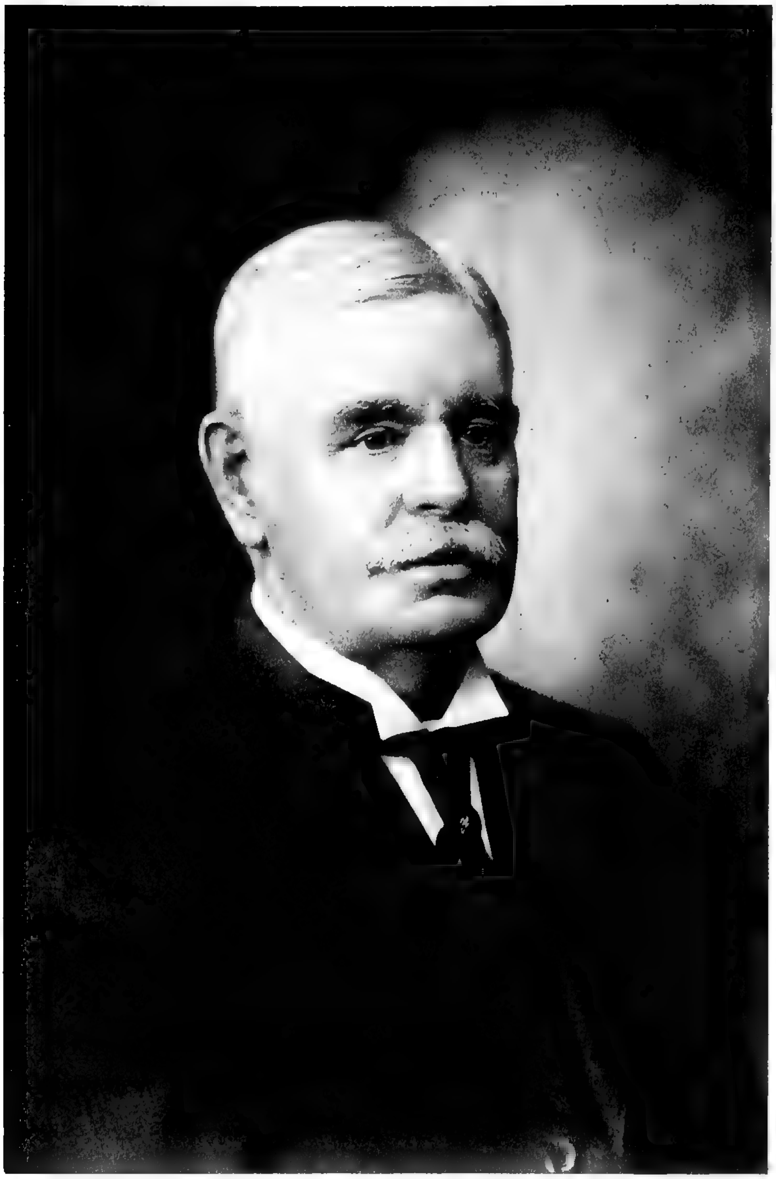
Some of the utility companies under Byllesby management, and in which Mr. Byllesby is either president or director are as follows: Northern States Power Company, serving Minneapolis, St. Paul, and the Central Northwest; Standard Gas & Electric Company, a holding company; Western States Gas & Electric Company, operating in California; Louisville Gas & Electric Company; Oklahoma Gas & Electric Company; Muskogee Gas & Electric Company; San Diego Consolidated Gas & Electric Company; The Arkansas Valley Railway, Light & Power Company, operating in Colorado over a wide area centering at Pueblo; Mobile Electric Company, and The Ottumwa Railway & Light Company.

In addition to the service outlined Mr. Byllesby's organization has been extensively employed in consulting capacities on large engineering works and in the making of critical examinations and reports relating to many public utility enterprises. Of recent years the activities of the house have further broadened in investment banking lines and in the development of oil and mining properties.

As President of this organization Mr. Byllesby has always performed the most active executive functions, giving personal supervision both to the financing and the engineering endeavors of his firm. Since he has headed his own organization Mr. Byllesby has been identified with the following hydro-electric developments: water power on the Muskingum River at Zanesville, Ohio; Big Fork development near Kalispell, Montana; Cannon Falls water power near Cannon Falls, Minnesota; Rapidan water power near Mankato, Minnesota; Appalachian Power Company's two hydro-electric plants on the New River in Virginia; and the Coon Rapids development on the Mississippi above Minneapolis.

At various times Mr. Byllesby has written and spoken on engineering subjects and subjects involved with problems of public utilities, and numbers of such articles and addresses have been published in technical publications and pamphlets.

ROBERT J. GRAF
Vice-President and Secretary



JOSIAH O. BENNETT
(DECEASED)

Although Mr. Byllesby has never held political office or been a candidate for such preferment he has given much time to civic duties, of late years devoting energy particularly to efforts having patriotic objects. Among other connections he is a member of the Executive Committe of the Universal Military Training League; director and Treasurer of the Chicago Civic Federation; member of the Finance Committee of the University of Illinois; member of the Executive Committee of St. Luke's Hospital, Chicago; and director of Chase House, Chicago. He has been a member of the American Society of Mechanical Engineers since 1883 and is a member of the American Institute of Electrical Engineers, American Society of Civil Engineers and the Western Society of Engineers.

Among the Clubs of which Mr. Byllesby is a member are the following: Metropolitan, Bankers, Recess, Railroad and Lawyers, New York City; The Chicago Club, Union League, University, Commercial, Mid-Day, Automobile and Glen View Country Clubs, Chicago; Lake Geneva Yacht Club and Lake Geneva Country Club, Lake Geneva, Wisconsin; Minnesota Club, St. Paul; Minneapolis Club, Minneapolis; Pendennis Club, Louisville; and the Arlington Club, Portland, Oregon.

Mr. Byllesby married Margaret Stearns Baldwin, daughter of the late H. P. Baldwin of Roselle, N. J., June 15, 1882. They reside in Chicago and at Holly Bush House, Lake Geneva, Wisconsin.

JOSIAH Q. BENNETT

The late Josiah Q. Bennett, of Cambridge, Massachusetts, was one of those far-seeing business men whose commercial abilities, formed such an important part in the promotion of electrical enterprises and made practical the applications which engineering skill and scientific research evolved for the generation and distribution of light and power.

He was born in Somerville, Mass., November 14, 1854, the son of Clark Bennett, of an old New England family. After his graduation from the Somerville High School he began his business career as a messenger in the old Maverick Bank, which was then the leading bank of Boston. His progress was steady and continuous, and he advanced in that institution until he became assistant cashier, remaining in that position until he was offered the post of cashier of the old Market Bank, of Boston, on State Street. After a considerable time in that connection he resigned it to become President of the Mercantile Trust Company, then located on the present site of the Shawmut Bank, in Boston. He remained with that institution until it was merged with others. He resolved to retire from banking entirely in order to give unhampered attention to his interests in manufacturing and public utility corporations, and therefore retired also from his membership of the board of directors of the Cambridge Trust Company.

It was when he was cashier of the Market Bank that he first became interested in industrial corporations. He brought to them the great organizing talent which was so large a factor in his success, and, after resigning from banking, he gave them constant and careful executive supervision.

There were among the enterprises of which he was the leading spirit several that had to do with gas and electric illumination. Foremost among them was the Cambridge Electric Light Company, of which he was President from 1887 until the date of his death. His was the financial and commercial acumen which made this company a model of service efficiency. He had a comprehensive knowledge of machinery, and matters of power and equipment in his properties were given their due prominence. The Cambridge Electric Light Company under his administration became a very successful enterprise. It was this company that had the distinction of furnishing the power for the first electric car operated in the vicinity of Boston. The other lighting and power corporations of which he was president were the Weymouth Light and

Power Company, Commonwealth Gas and Electric Company, Weymouth Water Power Company, Athol Gas and Electric Company, Marlboro-Hudson Gas Company, and the Marlboro Electric Company. He was also a director of the Amesbury Electric Light Company and the Dedham and Hyde Park Gas and Electric Company.

In the same year that he became president of the Cambridge Electric Light Company, Mr. Bennett also became president of the Fresh Pond Ice Company, which he built up to a leading place in the ice trade and organized with great efficiency. He was also president of the Metropolitan Ice Company and was the vice-president of Natural Ice Dealers' Association.

He was also greatly interested in the Boston Brick Company, of which he was the treasurer from 1903, and his counsels and interest in its business were leading factors in the success of that important corporation.

His organizing ability was widely recognized. One notable example of it was his rehabilitation of the Boston Woven Hose and Rubber Company, of which, as the result of financial embarrassment, he was made assignee. He reorganized it upon a more efficient basis than ever before, and, after turning it over to its new officers, he remained a director of the company.

He performed like good offices for the Purity Distilling Company, on behalf of the late Robert Mather, president of the Westing house Electric Company. He secured the buildings in Cambridge formerly owned by the Great White Spirit Company, which had long been vacant, and made them productive again, the Purity Distilling Company, of which Mr. Bennett was President, operating there the second largest plant of its kind in America. Both of these enterprises are now eminently successful. He was also a director of the Goepper Brothers' Barrel Company.

Mr. Bennett died at his home in Cambridge, Mass., November 28, 1916, leaving his wife, whom, as Miss Jennie Holland, he married in 1879, four children and six grandchildren.

PHILIP P. BARTON

The harnessing of the great power of Niagara Falls to provide electrically transmitted power for railroad propulsion and to turn the busy wheels of industry over a large area in the United States and Canada is an accomplishment which looms high among the mountain-tops of electrical achievement. The work connected with it was broadly planned and boldly executed by the services of a staff of skilled and progressive engineers who created The Niagara Falls Power Company. Among these was Philip Price Barton, who is now (1918) in the twentieth consecutive year of service with that company, of which he is now vice-president and general manager.

He was born in Lock Haven, Pennsylvania, May 5, 1865, and after completing primary and preparatory courses he entered Cornell University, from which he was graduated with the degree of Ph.B. and honors for general excellence, in the Class of 1886, following this up with two years of special studies in electrical engineering, leading to the degree of M.S., which he received in 1888. Following graduation he was employed for a few months with the Cambria Steel Company, at Johnstown, Pennsylvania, as a helper in the electric light plant, and with the Alleghany County Light Company of Pittsburgh, Pa., as office assistant. Following this work he became connected as an electrical engineer with the Westinghouse Electric and Manufacturing Company from 1888 to 1891, as erecting engineer at Pittsburgh and Chicago. From 1891 to 1898 he was in the employ of the Brush Electric Company and the General Electric Company at Pittsburgh. In 1898 he entered upon his long service with The Niagara Falls Power Company, beginning as assistant to the electrical superintendent. He made himself familiar with all the details of the construction and operation of that great plant and took personal part in the solution of the many problems and difficulties that had to be solved before the company reached the full realization of its perfect and unique service. His promotion to superintendent of operation followed his mastery of these problems, and later he was made general manager, which office

PHILIP P. BARTON

he still holds, and his good work has been further rewarded by election to the office of vice-president of the company. In addition to The Niagara Falls Power Company, Mr. Barton has long been similarly associated with the Canadian Niagara Power Company, first as superintendent of operation and for years past and now as general manager. The Canadian company serves the Canadian side upon methods identical with the service of the American company on its side of the boundary. Mr. Barton is also Vice-President and General Manager of the Niagara Junction Railway Company and the Niagara Development Company. He was formerly trustee of the Niagara Falls Public Library and director of the Young Men's Christian Association, and is now trustee of the Niagara Falls Memorial Hospital. He is a fellow of the American Institute of Electrical Engineers, member of the American Electrochemical Society, the American Association for the Advancement of Science, the Niagara Club, University Club, Niagara Falls Country Club, Buffalo Club, and the Engineers' Club of New York. In the branch of electrical engineering in which he is engaged, Mr. Barton's knowledge and experience make him a recognized leader.

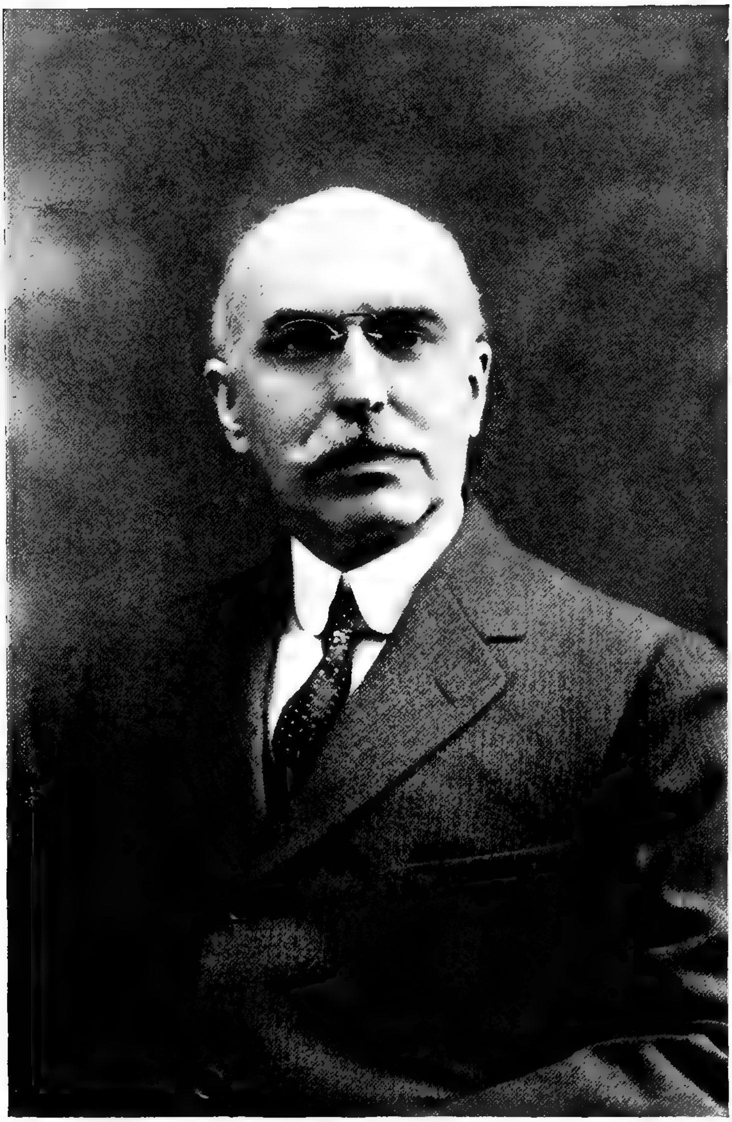
WILLIAM C. BOYRER

William C. Boyrer, electrical engineer, in charge of the Bond Issue investigations for the Public Service Commission, First District of New York, has made an exhaustive study of the whole field of appraisal work both on the basis of the cost to reproduce and the basis of actual expenditures. He has had great success both

WILLIAM C. BOYRER

in the investigation of current expenditures and past expenditures and has aimed to supplant the cost to reproduce method of appraisal by a method based upon the investigation of actual expenditures. Among the many bond cases Mr. Boyrer has successfully concluded are: The Interborough Rapid Transit Company, of New York, the amount involved being $5,409,000; the Third Avenue Railroad, $5,000,000, and the New York Edison Company, $24,000,000. He has also acted as Consulting Engineer for the Virginia State Commission in connection with the valuation for taxing purposes, and served in a similar capacity for the city of Memphis, Tenn., in connection with a rate case against the Cumberland Telephone & Telegraph Company, and for the State Board of Public Utilities of New Jersey in connection with the appraisal of the New York Telephone Company, in which $33,000,000 were involved. Mr. Boyrer has contributed articles on this subject and now (1917-18) has in preparation a book on valuation; he has also made a revision of the Uniform System of Accounts for the Public Service Commission for the First District, New York, accompanied by a pamphlet of instructions for the guidance of corporations in connection with the matter.

Mr. Boyrer was born in New York City, December 18, 1869, and was educated at private schools, the College of the City of New York, from which he graduated in 1890, and Cornell University, where he studied electrical engineering and received the M.E. degree in 1891, the M.M.E. being conferred one year later. His first active work was in 1892, when he became an employee of Queen & Co. at their laboratory in Ardmore, Pa., where for eight months he was engaged in developing a new type of D. C. central station ammeter and voltmeter. He was interested in the construction of electrical measuring instruments, which was a branch of Queen & Company's business, but had little opportunity to do more than make a preliminary study of the subject. Mr. Boyrer was at one period a foreman in the equipment department of the U. S. Navy at the Brooklyn Yard and was engaged in the installation of electrical apparatus on various men-of-war. He was also engineer of the Long Island Division of the New York Telephone Company. While connected with the telephone company he devised a type of private branch exchange, with interchangeable cord circuits, to be used on the common battery system. The principle of this board forms the basis for those now in use for this purpose. Mr. Boyrer is a member of the Cornell University Club, of New York; the American Institute of Electrical Engineers, and the Brooklyn Engineers' Club.



WILLIAM S. BARSTOW

WILLIAM S. BARSTOW

William S. Barstow was born in Brooklyn, New York, February 15, 1866. He entered the Adelphi Academy, in Brooklyn, in 1873, graduating in 1883, and then took the four-year classical course in Columbia College, New York, from which he was graduated B.A. in 1887, being a Commencement Speaker. While in college he entered the Delta Upsilon fraternity.

On graduation, he was offered a position in the Edison Machine Works at Schenectady, New York, where he began in July, 1887. He remained in that service at Schenectady, New York City, Paterson, N. J., the Edison Laboratory at Orange, N. J., and at Brooklyn. During that period his work was in the Testing Department and on underground and station construction. In 1889 (September) he accepted a position in the Edison Electric Illuminating Company, of Brooklyn, as electrical engineer. In 1890 he was appointed general superintendent, and later general manager, and remained in that connection until 1901. Under his supervision the Brooklyn Edison Company was one of the very first to install multiphase transmission and sub-station distribution, low tension arc lamps on the Edison system, storage batteries, the "booster" system, and the Leonard system applied to electric elevators.

Mr. Barstow resigned from the Edison Electric Illuminating Company of Brooklyn in 1901 to engage in private practice as a consulting electrical engineer. In 1906 he organized and became president of the corporation of W. S. Barstow & Company, construction engineers and managers of public utility properties.

He has taken out several patents for various inventions, including a "Porte Lumière," a two-rate meter, booster systems, a clock switch, and others.

Outside of the company bearing his name he is president and a director of some twelve public utility companies (and a director in nineteen others) operating in various sections of the country. His large activities and continued success have earned him a prominent place in the list of those operating electric light and other utility corporations.

He has had an active part and influential share in the progressive work which, during several decades past, has wrought such improvement in quality and expansion in area of service as has characterized the modern course of development of public utility enterprises in this country. He is an authority on matters of management and progress in electrical service organization. He has delivered addresses and presented important papers on professional subjects before the Columbia Engineering Society, the American Institute of Electrical Engineers, New York Electrical Society, the Franklin Institute of Philadelphia, Manufacturers' Association of Brooklyn, the Association of Edison Illuminating Companies, National Electric Light Association, and the Electrical Section of the Brooklyn Institute of Arts and Sciences. He has also published many valuable contributions on professional and technical subjects to the Electrical World, Cassièr's Magazine, and other scientific and engineering publications.

Mr. Barstow is a Fellow and Life Member of the American Institute of Electrical Engineers and has served as its Vice-President and as a member of its Board of Managers; has been President of the Electrical Section of the Brooklyn Institute of Arts and Sciences; is a Life Member and past President of the New York Electrical Society; was formerly secretary and treasurer of the Association of Edison Illuminating Companies, and was a member of the Jury of Awards in the Electrical Section of the Pan-American Exposition at Buffalo, in 1901. He is a member of the Illuminating Engineering Society, a charter member of the American Electrochemical Society, and member of the National Electric Light Association, The Columbia College Alumni Association, The Columbia University Club, the Lawyers' Club, Delta Upsilon Club (New York), and the North Hempstead Country Clubs.

In 1894 he married Francoise M. Duclos, of New Brunswick, N. J., and has one son, Frederic D. Barstow.

WILLARD E. BOILEAU

An electrical engineer whose experience and achievements cover a wide range of construction and operation of electric light, power and railway properties is Willard E. Boileau, now general manager of the Scranton Railway Co. He was born at Bath, Steuben County, New York, September 8, 1865 (of Huguenot descent), was

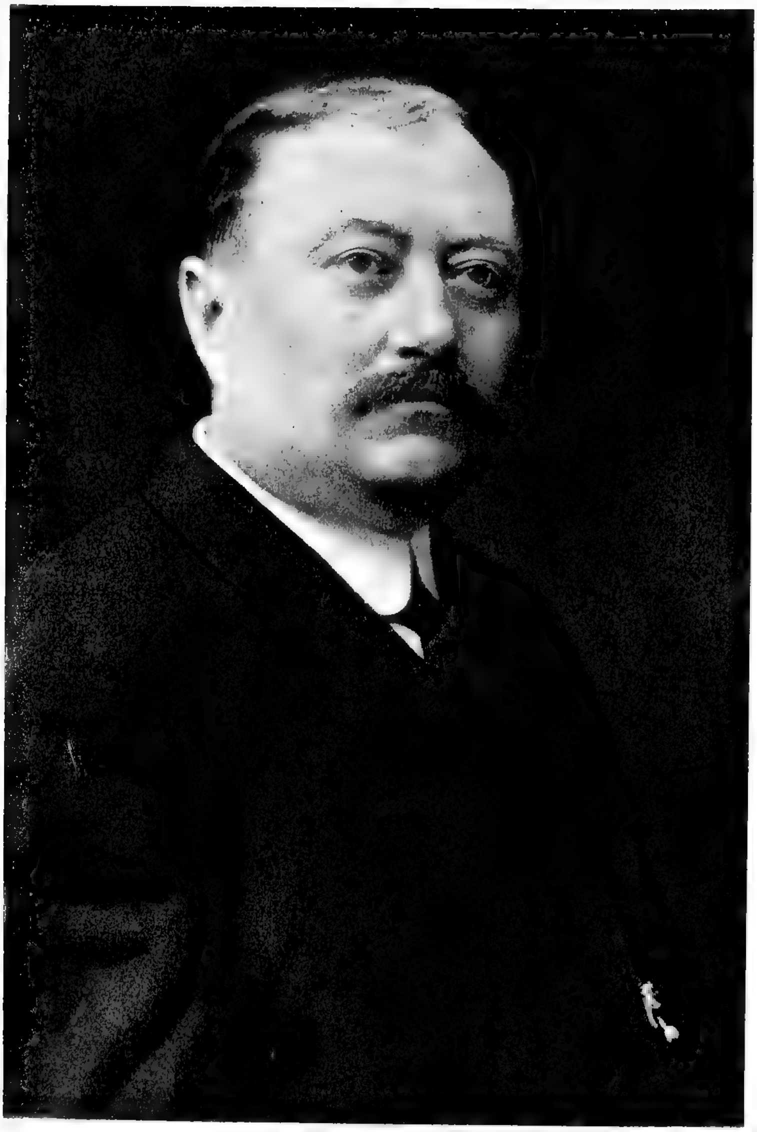
WILLARD E. BOILEAU

educated in Haverling Academy and High School at Bath, N. Y., and took a special course in drawing and mathematics.

He began his active business career with the contracting firm of Cram & Doty, and was later with the Delaware, Lackawanna & Western Railroad Company, first in construction work and later in train service. Believing that the electrical field furnished exceptional opportunities for a young man, he entered it in the employ of the Edison Manufacturing Company in 1886. In April, 1887, he went with the Thomson-Houston Electric Company, and in 1888 he took that company's special or "expert" engineering course in the factory at Lynn, Mass. He worked with Charles J. Van Depoele on railroad work in the factory, then went South in charge of construction of properties, and remained South constructing and managing lighting and railway properties until 1902, and then returned to the General Electric Company at the Schenectady plant. In 1903 he designed and constructed the steam turbine plant for Chattanooga, Tennessee; went to Dubuque, Iowa, in 1904, in charge of construction of the new steam turbine power station, tracks, car-barns and shops; thence to New York City in 1905, as designing mechanical engineer with the New York, Westchester and Boston Railway Company. Returning to Chattanooga in October, 1907, he remained as general manager of the Chattanooga Railway and Light Company, and of the Lookout Mountain Incline Company until 1914, when he took his present position as General Manager of the Scranton Railway Co.

Outside of his profession he is especially interested in the betterment of boys, and specifically in the Boy Scout Movement; and is a member of the Scout Council and Past Commissioner Scranton Boy Scouts. He is also vice-president of the Railroad Young Men's Christian Association.

He is a member of American Institute of Electrical Engineers, Engineering Society of Northeastern Pennsylvania; past president of the Scranton Rotary Club, member Scranton Club, Country Club, Elks; is a Thirty-second Degree Mason and Knight Templar; member of the New York Railroad Club, and director of the Scranton Board of Trade.



EDGAR G. BERNARD

(DECEASED)

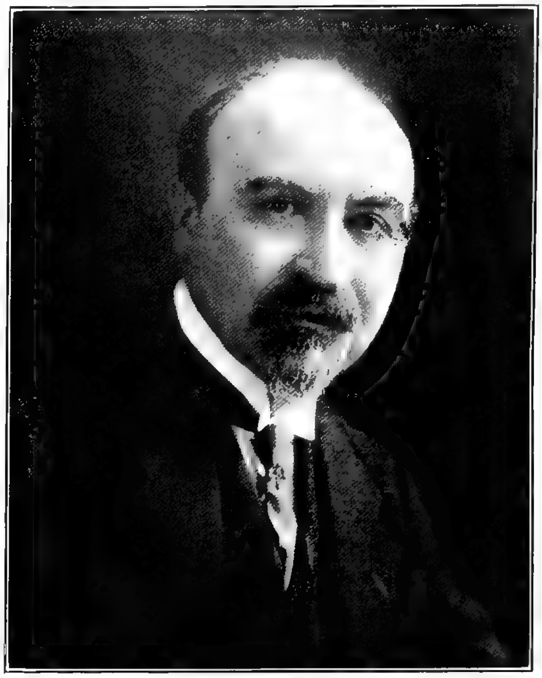
EDGAR G. BERNARD

Edgar G. Bernard, who died at Troy, February 23, 1915, began his electrical career in 1879 at the age of seventeen, his first electrical experience being gained in installing an arc-light plant in New York City for Booth's Theatre in that year. With the appearance of the incandescent lamp, he at once entered into isolated-plant lighting, which field he was probably the first to work systematically as a salesman and also as an engineer in the development of the constructional details. In 1884 he became chief sales agent and constructing engineer for the Sawyer-Man Company, continuing in the same capacity with its successor, the Consolidated Electric Light Company. When the latter was purchased by the Westinghouse Company, about 1888, he remained in charge of its textile-mill work until shortly before establishing his own business at Troy, in the fall of 1890. A few years after starting business in Troy, Mr. Bernard began the manufacture of dynamos and motors especially adapted to his line of work, which he continued until satisfactory machines could be obtained elsewhere. His electrical activities covered a wide range, including in early days town arc and incandescent lighting. Much of his work has been special in character, such as the installation of 7,000 lamps in the Capitol at Albany in twenty-five working days, practically all of this work being special construction; the generator and motor equipment of the United States Arsenal at Watervliet; marine installation work for the United States Navy and for shipyards, etc. Mr. Bernard joined the American Institute of Electrical Engineers in January, 1886, and was a member of many electrical bodies, including the Electrical Supply Jobbers' Association. For a quarter of a century or more he was a regular attendant at conventions. He was president of the Troy Electrical Company, successor to the E. G. Bernard Company.

The above obituary from the *Electrical World* of March 13, 1915, is but a brief summary of the life of a most energetic and popular member of the electrical fraternity; one known to many of the pioneers in this profession, and whose memory remains green as long as his generation survives. He has been succeeded by his son as the head of the Troy Electrical Company.

LEO HENDRIK BAEKELAND, B.S., Sc.D.

Leo Hendrik Baekeland, one of the country's eminent chemists, was born November 14, 1863, in the old Flemish city of Ghent, Belgium, where he received his preparatory education in the elementary schools, the Atheneum (a Government High School), and the Ghent Municipal Technical School. He entered the University of Ghent in 1880, where he studied various sciences and specialized in chemistry, and when only twenty-one years of age was awarded the degree of Doctor of Science, passing his examinations with the highest honors. He was later appointed Assistant Professor and in 1889 Associate Professor. In the meantime, in 1887, he had been appointed Professor of Chemistry and Physics at the Government Normal School, then existing in the city of Bruges. While a resident of Ghent, Dr. Baekeland became deeply interested in photography, and as that city was the center of the new industry of dry-plate manufacture, he acquired a vast knowledge of this new branch of the chemical industry. Upon coming to New York City he accepted the position of chemist with the firm of E. & H. T. Anthony & Co., who were manufacturers of films and bromide paper. He resigned this position at the end of two years, and in 1893, in partnership with Leonard Jacobi, founded the Nepera Chemical Company at Yonkers and began the manufacture of photographic papers. One of these was "Velox," which Dr. Baekeland perfected and afterward sold to the Eastman Kodak Company in 1899. This sale netted him enough to gratify his personal inclinations, and he immediately turned his attention to electrochemistry and organic chemistry. In this latter field he has taken out upwards of fifty patents, covering many processes previously unknown in the field of chemical industry, one of which was "Bakelite," a new material that Dr. Baekeland gave to the world. It is a chemical synthesis from carbolic acid and formaldehyde, replacing hard rubber and amber, and is used in the manufacture of thousands of articles and for endless electrical purposes. The General Bakelite Company has a very complete plant at Perth Amboy, N. J. Several plants have been established, under license, throughout the United States, Germany, France and England; before the war at least two factories in Germany and one in Russia were devoted to the manufacture of "Bakelite" buttons alone. Dr. Baekeland, as consulting chemist, assisted in the development of the Townsend electrolytic



LEO HENDRIK BAEKELAND.

cell for the Hooker Electrochemical Company of Niagara Falls, N. Y., in 1903. He was Honorable Professor of Chemical Engineering at Columbia University in 1917, and the other honors conferred upon him are many. He was awarded the Nicholls Medal by the American Chemical Society in 1909; the John Scott Medal by the Franklin Institute in 1910; the Willard Gibbs Medal by the American Chemical Society, Chicago Section, in 1913; the Chandler Medal (First Award) by Columbia University in 1914; the Perkin Medal for Industrial Chemical Research by the Affiliated Chemical and Electrochemical societies in 1916. Dr. Baekeland was the first Chandler lecturer at Columbia on the occasion of the 50th anniversary of the School of Mines in 1914, was United States Delegate to the International Congress of Applied Chemistry, held in Lon-

MARTIN BERTHOLD

don in 1909, and was president of the Section of Plastics, International Congress of Applied Chemistry, New York, 1912. He was president of the Inventors' Guild in 1914, president of the American Institute of Chemical Engineers in 1912, vice-president of the American Electrochemical Society in 1909, chairman of the New York Section in 1908 and councilor-at-large in 1907, later becoming president. He is also an honorary member of Gamma Chapter, Phi Lambda Upsilon, and was appointed to membership of the Naval Consulting Board in 1915. He is also a member of the National Research Council and the Nitrate Supply Committee for the Army and Navy. His clubs are the Chemists, of which he was president in 1904, the University and Century of New York City, and the Cosmos of Washington, D. C.

MARTIN BERTHOLD

An electrical engineer of distinction in the field of design and adaptation of electrical generators and motors for alternating and direct currents is Martin Berthold, of Akron, Ohio.

Mr. Berthold was born at Oberholz, near Leipzig, Saxony, on September 6, 1877. His general education was received at the Freimaurer Institute, Dresden, Saxony, and his technical education at the Maschinenbau Schule, Technische Staatslehranstalten, Chemnitz, Saxony, from which he was graduated in 1897, with special courses in electrical engineering and mathematics. His interest in electrical work was greatly stimulated by the course of lectures by Professors Weinhold and Koller, at Chemnitz, in physics and electrical engineering, and he became especially interested in the fundamental data on design of electrical machines, as far as such data were available up to 1897, and followed up the same subject until 1900 by extensive private study and visits to such electrical manufacturing concerns as were accessible.

He began his practical professional work by systematically prepared apprenticeship courses in the Shop Department of J. M. Grob & Co., Leipzig, manufacturers of gas engines and electrical machinery. He served for a time as an assistant to the chief engineer of Dr. G. Langbein & Co., Leipzig, later becoming electrical engineer with the Allgemeine Electrizitaets Gesellschaft, Berlin.

Coming to the United States, he became a technical clerk in the testing department of the Western Electric Company at Chicago, and from there went to Indianapolis, Ind., becoming assistant electrical engineer of the Commercial Electric Company there, and later, in the same city, was with the Fairbanks-Morse Electrical and Manufacturing Company, as engineer in charge of design, and afterwards as chief engineer of the electrical department. He subsequently became chief engineer of the Ideal Electric and Manufacturing Company of Mansfield, Ohio, and thence went to his present connection as chief engineer of the Imperial Electric Company of Akron, Ohio.

The work of Mr. Berthold since 1900 has been in the direction of greater refinement in the design of electrical motors and generators for alternating and direct currents. His observations of phenomena have made it apparent that in order to secure the highest efficiency the observations of the machine-test must check the calculations of the machine design. In his work toward increased efficiency alternating current machinery has been developed with as much zeal as direct current machinery, though the one class does not supplant the other. As the field of application of each may be accurately defined, the commercial advantages attained have justified the pains taken and the labor expended in the development of both.

Mr. Berthold became a citizen of the United States on March 12, 1912. For the benefit of the Naval Consulting Board he has compiled the inventories of five manufacturing concerns of the City of Akron, including his own company.

He is a member of the Verein Deutscher Ingenieure, American Institute of Electrical Engineers and National Geographic Society.

BERNARD ARTHUR BEHREND

Distinguished equally for scientific knowledge and constructive achievement, Bernard Arthur Behrend is an electrical engineer of more than national prominence.

He was born near Chillon Castle, Canton de Vaud, Switzerland, May 9, 1875; was educated by private tutor, pursuing his studies in England and France

BERNARD ARTHUR BEHREND

and as a special student at the University and Polytechnic Institute at Berlin. He became assistant to Professor Kapp, and later was assistant chief engineer of the Oerlikon Company, of Switzerland. His parents coming to this country he embarked upon advanced work as chief engineer of the Bullock Electric Manufacturing Company, and later as chief electrical engineer of the Allis-Chalmers Company, the electrical department of which he established and organized, and as consulting engineer of Allis-Chalmers-Bullock, Limited, of Montreal.

As consulting engineer Mr. Behrend has been identified with many important achievements, including much work in which he has pioneered the way to advanced engineering practice. One of the most interesting of these electrical achievements was the linking together at Montreal in 1901 of the power from the Lachine Rapids, the Montreal Light, Heat and Power Company, and Shawinigan Falls, eighty miles from Montreal. Mr. Ralph D. Mershon designed the 60,000-volt transmission line from Shawinigan Falls to Maisonneuve, Mr. Behrend designing the frequency-changing apparatus at Maisonneuve, linking successfully together, for the first time, three great power stations operated by different types of prime movers.

In 1904, the United States Steel Corporation reconstructed all its power houses at Carey Furnaces, Homestead, Pa.; the American Steel and Wire Company, Cleveland, Ohio; the Illinois Steel Company, South Chicago, and the Indiana Steel Company, Gary, Indiana, utilizing furnace gas for the operation of giant gas engines. The entire electrical planning of these installations, involving for the first time in this country the successful solution of the problem of parallel operation of gas engines, was in Mr. Behrend's hands, and was completed without the usual method of trial and error, all the plant operating in multiple perfectly.

The development of the turbo-generator with cylindrical cores and radial slots was due to Mr. Behrend, all American manufacturers now using the type which he developed in 1902. The Theory of the Induction Motor as first presented by him in 1895, and the Theory of the Regulation of Alternators as presented by him in 1896-1897, have long been generally adopted, and the Rules of the Standards Committee of the American Institute of Electrical Engineers conform to his recommendations, based on his theoretical and experimental work.

At the end of 1908 he was called by the Westinghouse Reorganization Committee to Pittsburgh to redesign the electrical machinery and types of the Westinghouse Electric and Manufacturing Company. He has remained Consulting Engineer for this organization in connection with similar work.

His achievements secured him the Gold

CHARLES S. BRADLEY

Medal of the Louisiana Purchase Exposition at St. Louis in 1904, and the John Scott Medal of the Franklin Institute, Philadelphia, 1911. He is author of: "The Induction Motor—Its Theory and Design" (1900, in French 1902, in German 1903); "The Debt of Electrical Engineering to C. E. L. Brown" (1901); "Engineering Education" (1907); and many monographs on the theory of alternating currents, motors and generators in American and European publications.

He is a fellow and vice-president of the American Institute of Electrical Engineers; fellow of the American Academy of Arts and Sciences, and the American Association for the Advancement of Science; member of the American Society of Mechanical Engineers, American Society of Civil Engineers, Engineers' Club (Boston) and Engineers' Club, New York.

CHARLES SCHENCK BRADLEY

Holding a place of recognized prominence among the engineers and inventors who in recent years have so successfully harnessed the resources of science to the motive forces of industry and progress is Charles Schenck Bradley, whose electrical and electrochemical researches and inventions have been made the basis of several thriving and important enterprises.

Mr. Bradley was born in Victor, Ontario County, New York, April 12, 1853, the son of Alonzo and Sarah (Schenck) Bradley. On the paternal side the original surname of his family was Foskett, his first American ancestor being John Foskett, who came from Bristol, England, to Charlestown, Mass., in 1648. For some undiscovered reason Mr. Bradley's paternal grandfather, Samuel Foskett, secured a legal change of name from "Foskett" to "Bradley" from the Massachusetts Legislature in 1820. Mr. Bradley's earliest maternal ancestor in America was Roeloff Schenck, from Holland, who settled at Flatlands, on Long Island, in 1650, and was a son of Sir Martin Schenck, of Holland. Thus in both lines Mr. Bradley belongs to racial elements which enter into the best American citizenship.

Mr. Bradley was educated in the schools of Rochester, New York, and took chemical courses at the University of Rochester, supplemented by persistent study and reading of books of scientific knowledge, and took great interest in all matters of applied science and particularly in chemistry and electrical science. He began the active practice of his profession with the Edison Illuminating Company, from July 5, 1881, to 1883, in which connection he was in intimate association with Thomas A. Edison in the working out of electrical problems. He then organized his own laboratory in New York City, in which he developed his discoveries and inventions in connection with the multiphase transmission of power. Since then, as a practicing electrician, he has been retained on inventive work with the Fort Wayne Electric Company, Thomson-Houston Electric Company and the General Electric Company. His electrical inventions and researches have been largely connected with the development and application of the alternating current, power transmission, motors, and many new and valuable applications of electrochemistry.

Among the scores of patents which have been issued to Mr. Bradley are many which cover basic applications of electric and chemical science to many useful ends of the highest economic and industrial importance. One sphere of usefulness in which he has gained widespread prominence is that of the fixation of nitrogen. In the wonderful advance in agriculture it has been demonstrated that many chemical elements most necessary to the vitality of important food crops are, so far as present known sources of supply can make them available, rapidly approaching exhaustion. This is especially true with respect to the nitrates which are especially necessary to the production of wheat and other grains, the approaching famine of which chemical authorities have been actively predicting for several years. These predictions did not take into account the fact that the air contained practically unlimited supplies of nitrogen, but the processes known to analytical chemistry made it impossible to separate and fix the nitrous elements of the atmosphere so as to make

them available to the uses of agriculture. Mr. Bradley, taking hold of this problem, devised a method by which by means of the generation of a number of electric arcs in a confined space, through which atmospheric air in regulated and continuous flow is forced and emerges from this superheated vehicle laden with nitrous oxides and peroxides resulting from the combustion and ready for chemical treatment and collection. Thus opening a way for producing this most essential ingredient of plant food, Mr. Bradley established and is president of The Atmospheric Products Company for the Fixation of Nitrogen; and is licensor of the Hope Company, Inc., engaged in the same industry. He is also president of the Ampere Electrochemical Company, engaged in the general practice of electrochemistry. Mr. Bradley is also inventor of electrochemical processes for ore reduction, including a process for reduction of copper, operated by the Bradley Copper Process Company, of which he is vice-president; and he is inventor and licensor to the United States Reduction Company, Inc., for the reduction of iron by natural gas. He is a member of the Chemists' Club, of New York; the American Chemical Society, American Association for the Advancement of Science, Franklin Institute, American Institute of Electrical Engineers, and the Genesee Valley Club, of Rochester.

Mr. Bradley was from 1906 to 1907 acting professor of chemical practice in the Carnegie Technical Schools and is a distinguished leader in practical applications of electrochemistry.

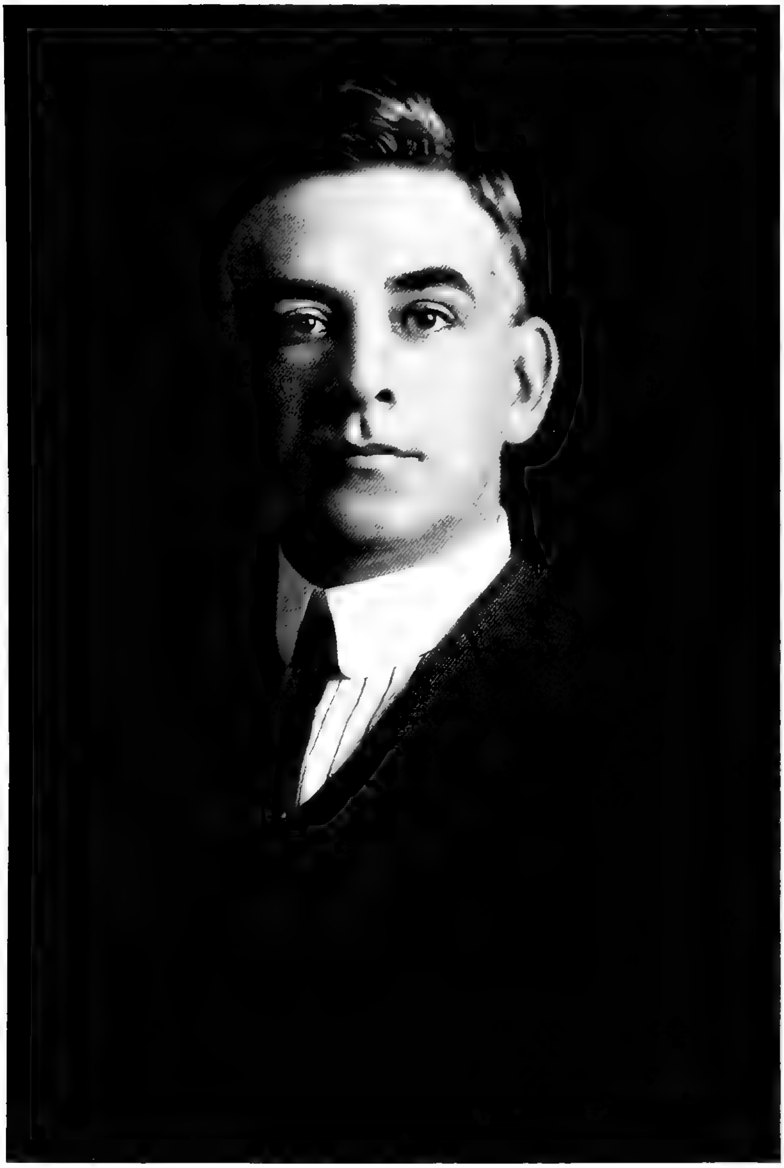
HENRY J. BLAKESLEE

The development of the electrical industry has been greatly aided by the invention and use of improved instruments of precision for the measurement and testing of the machines and apparatus used in various ways for electrical operation. By means of these improved devices electrical measurements and values have been brought to a high degree of exactness. Their creation is the work of electrical engineers of exceptional scientific attainments. Among those who have specialized along this line with a record of commendable achievement is Henry J. Blakeslee, M.S., now treasurer and electrical engineer of The States Company, of Hartford, Connecticut.

Mr. Blakeslee was born in Hartford, a descendant of colonial stock of early New England, on August 15, 1876. He was educated in the public and high schools of Hartford and in Trinity College, Hartford, from which he was graduated with the degrees of B.S. in 1898 and M.S. in 1901 after post-graduate work in physics and electricity. While at Trinity he received election to the Alpha Chi Rho fraternity.

A natural preference for science and engineering had led him to specialize in studies along that line, and training and opportunity furnished further incitement, leading him into the electrical profession, in which he has pursued a successful and constructive career. He began in 1900 with the Hartford Electric Light Company, at Tariffville, Connecticut, as field engineer and superintendent in charge of construction of the hydro-electric power plant. Upon the completion of that work he became electrical inspector for the New England Insurance Exchange, and later served the Underwriters' Association of the State of New York in a like capacity. After that he was in the service of the City of Syracuse, New York, continuing until taking his present connection as treasurer and electrical engineer of The States Company, of Hartford.

With that company Mr. Blakeslee has been actively engaged in the development of what is practically a pioneer line of electrical apparatus used in testing by central stations not only in all sections of the United States, but also in many other countries. The line has been developed with infinite carefulness and has attained a high reputation with electrical people. It has kept up with the march of events in things electrical, and the line is notable for its unique completeness. Especially interesting from the point of view of

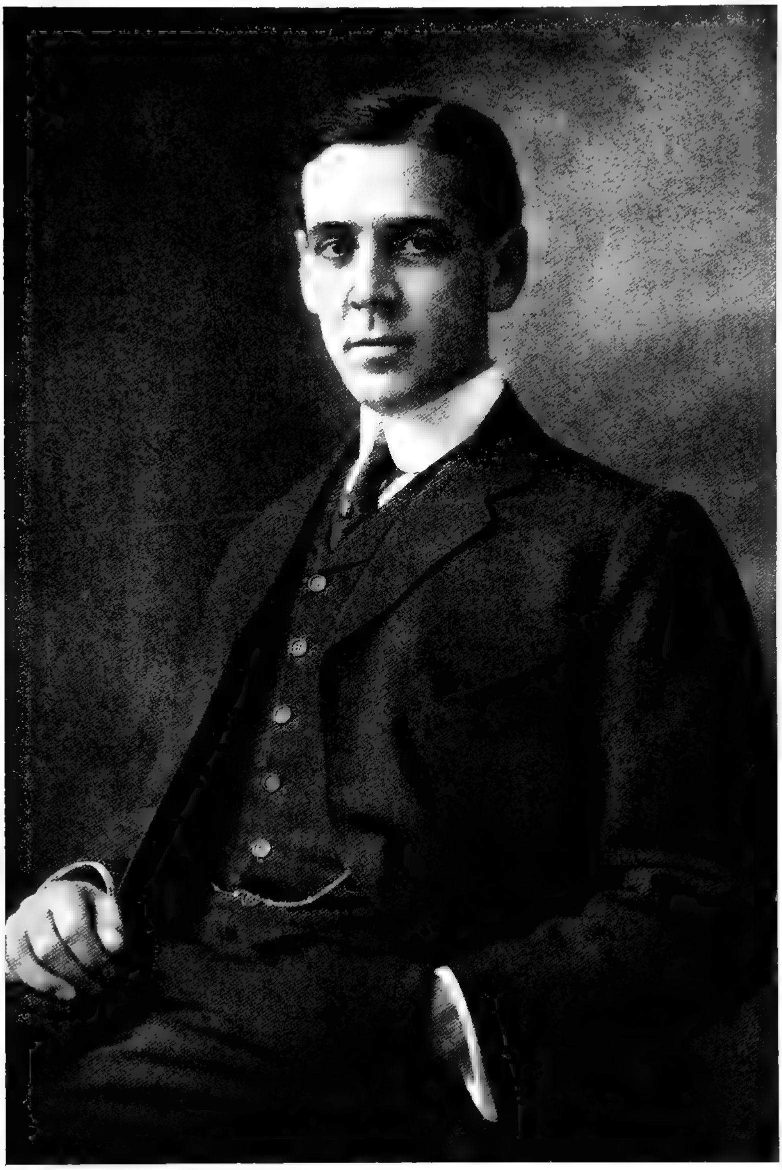


HENRY J. BLAKESLEE

electrical men connected with electric light and power companies and particularly those engaged in electrical measurements are the "Phantom Load" and "Phase Shifter" devices, which are now so widely used in meter testing. These devices, which were practically unknown ten years ago, are now used with great satisfaction by thousands of electrical men, who are making their work more effectual by their use.

In the introduction and development of this line of useful devices Mr. Blakeslee has done constructive and pioneering work, and was the first person to standardize and to develop to commercial practicability a line of meter testing devices such as is at present manufactured by The States Company. The line, though somewhat restricted in range, is of much technical and scientific importance.

Mr. Blakeslee is a member of the American Institute of Electrical Engineers and of the National Electric Light Association.



LE ROY CLARK

Le Roy Clark, president of the Safety Insulated Wire & Cable Company, is a native of New York City, where he was born February 16, 1872. His technical training was at the School of Mines, Columbia University, from which he graduated in 1894. A year previous to this period he had entered the employ of the Safety Insulated Wire & Cable Company as electrician, devoting his time to machine shop and wireless work. He was soon made Electrical Engineer of the company and successively filled the offices of Assistant General Manager and Vice-President until he was elevated to the presidency ten years ago. He is a member of the Lawyers' Club, Englewood Country Club, Englewood Club and the Electrical Manufacturers' Club. Mr. Clark's business address is at 114 Liberty Street, and he resides at Englewood, N. J.

COL. JOHN J. CARTY

COL. JOHN J. CARTY

John J. Carty was born in Cambridge, Mass., April 14, 1861. After completing the course in the Cambridge Latin School, he entered the employ of the Telephone Dispatch Company of Boston in 1879, where his natural aptitude for mechanics and love of scientific investigation attracted him to the technical side of the telephone business, in which he developed rapidly, contributing many important advances in the art of telephony. Among his most notable achievements of this period were the invention of a test system for multiple switchboards and the installation of the first metallic circuit multiple switchboard.

In 1887 he was placed in charge of the cable department of the Western Electric Company in the East, and later of the switchboard department. While at the head of these departments he made many important improvements in the design and installation of telephone cables and switchboards, including a fundamental invention upon which is based the common battery switchboard now in almost universal use.

In 1889 he entered the service of the Metropolitan Telephone and Telegraph Company, now the New York Telephone Company, as Electrician, and later was made Chief Engineer of the company. Under his direction the technical foundation for the comprehensive New York telephone system was established.

In 1907 he was appointed Chief Engineer of the American Telephone and Telegraph Company. With a large staff of technically trained assistants he directs the engineering work of the Bell System. Many important advances have been made toward the realization of universal service in the Bell System under his leadership. Among these notable achievements are:

The transcontinental telephone line, 3,400 miles long, which was formally opened for commercial use, Jan. 25, 1915, connecting San Francisco and New York, many times longer than any other telephone line in the world.

The Washington to Boston underground cable system, 450 miles long, by far the longest underground cable system.

The successful demonstration of wireless telephony made by the Bell System under Col. Carty's direction in September, 1915, when President Theodore N. Vail at his office in New York talked by wire to the Naval Radio Station at Arlington, Va., and thence by wireless across the North American Continent to the Navy Yard at Mare Island, California, where Mr. Vail's words were heard and understood by Col. Carty and other engineers and naval officers.

The establishment of wireless telephone communication from the Naval Radio Station at Arlington, Va., to the Hawaiian Islands and to the Eiffel Tower at Paris, in France.

To Col. Carty's original research are due the modern theories of telephone induction and cross-talk and the theory of the transposition of telephone circuits. He has also been granted many patents for inventions and improvements in the art of telephony.

The Franklin Institute of Philadelphia awarded him the Edward Longstreth medal of merit for his engineering work and later the Franklin medal, the highest honor bestowed by the institution.

For his work in the science and art of telephone engineering, the American Institute of Electrical Engineers awarded him the Edison medal.

He is one of the leaders in the movement to encourage scientific research in the universities and among the industries, being Chairman of the Executive Board of the National Research Council, founded by President Wilson; trustee of the Carnegie Institution at Washington; director of the Research Corporation; member of the National Academy of Sciences; Fellow of the American Academy of Arts and Sciences; Fellow of the New York Academy of Sciences; Fellow of the American Institute of Electrical Engineers; Past President of the New York Electrical Society; member of the Society for the Promotion of Engineering Education, the National Society for the Promotion of Industrial Education, the American Physical Society, the Franklin Institute, the American Association for the Advanceemnt of Science, the Society of Arts and the American Geographical Society.

He is a member of the St. Botolph Club,

Boston, and the Century, Lotos, Engineers' and University clubs, New York.

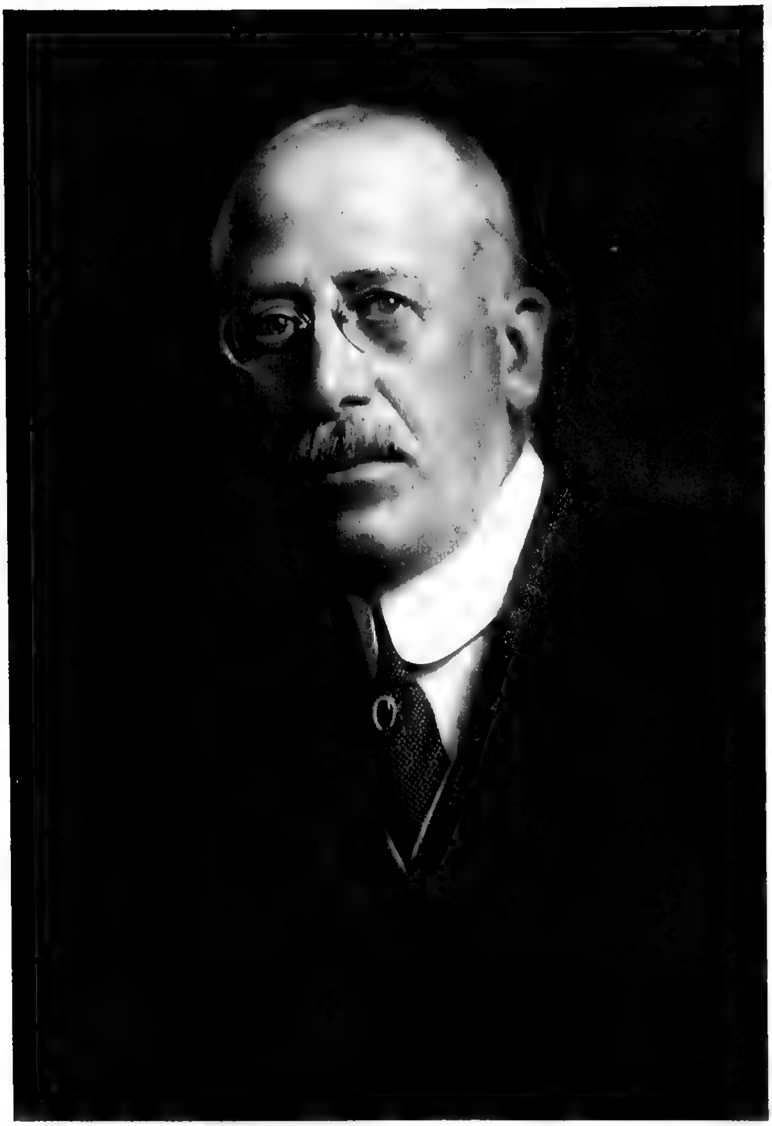
The Emperor of Japan decorated him with the Imperial Orders of the Rising Sun and the Sacred Treasure of the Meiji and the Imperial Government of Japan has twice tendered him its formal thanks for his services in connection with the establishment and development of the telephone system in Japan.

Mr. Carty received the honorary degree of Doctor of Engineering from the Stevens Institute of Technology; the degree of Doctor of Science from the University of Chicago and from Bowdoin College, and the degree of Doctor of Laws from McGill University. During the period of 1915-1916 he was President of the American Institute of Electrical Engineers.

Previous to the entrance of the United States into the World War, and working in conjunction with officials of the United States Navy, Mr. Carty planned the mobilization of the communication forces of the U. S. Navy, which was successfully carried out on May 6, 7 and 8, 1916, when for three days war conditions were simulated and war plans perfected which were put into practice when the United States entered the war. During this mobilization the Secretary of the Navy, Hon. Josephus Daniels, talked from his desk in Washington by radio telephone to the battleship New Hampshire at sea. Throughout the entire period of the mobilization Captain Chandler, in command of the New Hampshire, was in constant touch with Admiral W. S. Benson, in charge of naval operations at the Navy Department in Washington. This is the first time such an achievement had been accomplished.

Mr. Carty was offered a commission as Major in the Signal Officers' Reserve Corps, which he accepted and was commissioned on January 6, 1917.

With the generous encouragement of the American Telephone and Telegraph Company, and acting in conjunction with the Chief Signal Officer of the United States Army, he organized among the employees of the Bell System twelve battalions of trained signal corps troops who were ready to be called into service when the war broke out. On April 20, 1917, two weeks after the entrance of the United States into the war, Mr. Carty was called to active service and on August 15, 1917, he was promoted to Colonel in the Signal Corps, U. S. A.



EDWARD A. COLBY

EDWARD ALLEN COLBY.

Edward A. Colby, of Newark, New Jersey, who has spent a lifetime in electrical research work and who during his long activity has done much for the advancement of that science, was born in St. Johnsbury, Vermont, August 1, 1857. He is the son of James Kelsey Colby, a graduate of Dartmouth College, class of 1838, who was principal of the St. Johnsbury (Vermont) Academy from the foundation in 1842 until his death in 1866, and is directly descended from Anthony Colby, of Lincoln, England, who settled in Salisbury, Mass., in 1660. Mr. Colby attended the St. Johnsbury Academy, the Hillhouse High School, New Haven, Conn., and Yale University, graduating from the last-named institution in 1880 with the Ph.B. degree. He taught sciences and mathematics at the Norwich Free Academy following his graduation and in August, 1881, entered the employ of the U. S. Electric Lighting Company, in their New York factory at Avenue B and Seventeenth Street, beginning his electrical work as an armature winder, rising to the position of assistant engineer and specializing in incandescent lamp design. During his connection with this company he was engaged in assembling generators and arc lamps and the installation of outside lighting plants, both arc and incandescent. While at college Mr. Colby had taken special courses in chemistry and physics. There was no course in electrical engineering existing prior to this time, but as lecture assistant to his professor in physics he had acquired interest in the problems awaiting solution in the then new field of work—electrical engineering—and this interest was intensified by the advice of his professor in mathematics who had resigned and entered the employ of the Thomson-Houston Co. at New Britain, Conn. From 1882 until July, 1886, Mr. Colby was engaged in experimental work leading to the perfection of design and construction of incandescent lamps, culminating in the Weston-Nitro-cellulose base for the carbon filament, which until the recent substitution of metallic filaments was universally used by lamp manufacturers. Innumerable experiments were conducted and processes perfected, but not published, many of which, such as gas-filled lamps, have been reinvented, all pioneer work essential to the development of a new art, but not easily decipherable as notable achievements at this late date.

An interesting incident, showing the then existing conditions in the electrical field and illustrating by comparison with present conditions how the science has progressed through the efforts of its pioneers, occurred in July, 1881, when Mr. Colby applied for a position with the Thomson-Houston Co., then located at New Britain, Conn. Prof. Thomson, E. W. Rice and one other assistant then constituted the laboratory force, and Prof. Thomson was so doubtful of their financial success that he considerately advised Mr. Colby to form a connection with a company of undoubted financial backing. The U. S. Electric Lighting Co. operated two plants in New York City and in 1881 acquired the Weston System, in Newark, N. J. Pending the completion of a research laboratory in charge of Dr. Edward Weston in Newark, Mr. Colby entered the New York factory under the supervision of the late Sir Hiram Maxim, who was chief electrician. Here he did a great variety of electrical work, much of which could be classed as pioneering, including the first installation of incandescent lighting on the North River ferry-boats, among which was the old "Jersey City" of the Pennsylvania Railroad service, plying between Desbrosses Street, New York, and Jersey City. Moving to Newark, N. J., in 1882, Mr. Colby joined Dr. Weston's laboratory staff and devoted the following four years to the development of the nitro-cellulose filament for incandescent lamps. Incidentally in these early days much work was done in allied lines, generator and motor designs, testing and the design and construction of electrical measuring instruments. In 1889, after the Weston Electrical Instrument Company was organized, Mr. Colby was engaged as electrician and gave

the first public demonstration of the now universally recognized merits of the Weston electrical measuring instruments by using the first completed volt meter as a standard in comparing the unit of voltage used in the various incandescent lamp factories. In 1891-2 Mr. Colby widened his experience by serving as resident engineer in building trolley roads and power plants in San Antonio, Texas, and in Pennsylvania and Maryland. In 1887 he applied for patents on an induction electric furnace for the melting and casting of metals, the distinguishing feature being the absence of electrodes and incident contamination of the molten charge therefrom. The design also included the melting and casting of metals either in a vacuum or any desired atmosphere. Basic patents were granted before it was possible to obtain alternating current generators suitable for its operation, and the original patents expired before steel makers in this country recognized their value; nevertheless Mr. Colby was the first to make what is known as electric steel in this country. Modified forms of his original design in sizes from laboratory models up to 15 tons capacity of molten steel are now in daily use in this country and abroad. As a pioneer in this field, Mr. Colby has been awarded the John Scott Medal and Diploma of the Franklin Institute of Philadelphia. Mr. Colby's original furnace patents anticipated the better advertised Kjellin's by some twelve years. Their separate interests, together with those of several other inventors, were brought together in 1907 under the control of the American Electric Furnace Company. Mr. Colby's induction furnace was originally designed for melting refined metals and casting them, freed from gases. Working at ordinary frequencies and voltages the sectional area of iron required in the core necessitated a secondary charge of metal to be melted, in excess of that available for ordinary billets of a precious metal—such as platinum. Working with high frequency currents, using spark gap, air blast and condensers, Mr. Colby was able in 1893 to melt platinum as the secondary conductor of a coreless transformer and so reduce the metal charge to a minimum. Recent work by others along this line gives great promise that a coreless induction furnace of commercial efficiency may shortly be available for melting metals of high intrinsic value, such as gold and platinum. Since 1893 Mr. Colby has given his attention chiefly to electrochemical and electro-metallurgical problems in connection with the commercial application of his electric induction furnace and to the various chemical and mechanical problems incident to the refining and working of the platinum group of metals, in which latter work for the past twenty-five years he has been the chief engineer and superintendent of the Baker Platinum Works, whose large plant is located at 54 Austin Street, Newark, New Jersey. Mr. Colby became a member of the Electric Club in 1887, and also holds membership in the Olympic and Yale Clubs of New York City, the American Institute of Electrical Engineers, the American Electrochemical Society, the Society of Chemical Industry, American Chemical Society and the National Geographic Society. In addition to his connection with the Baker Platinum Works, Mr. Colby was president of the Induction Furnace Co. until its absorption by the American Electric Furnace Co., of which he became vice-president and consulting engineer. He has also acted as consulting electrical engineer for the Westinghouse Electric Co., the Consolidated and Sawyer-Mann Electric Companies and for Charles H. Davis in his Texas, Pennsylvania and Maryland work. Mr. Colby is married and resides at 74 Hedden Terrace, Newark.

WALTER GORDON CLARK

Walter Gordon Clark, born in Salt Lake City, Utah, Oct. 23d, 1876, is the son of Thomas A. and Eunice M. (Wright) Clark. He was educated in the public schools, Salt Lake City Academy, and technical schools in San Francisco, California. He began his electrical work with the Rocky Mountain Bell Telephone Company while attending school in 1889, and continued with the Salt Lake Street Railway Company and with the R. M. Jones Electrical Company, of Salt Lake City, while in school.

Upon completing his school work in San Francisco he became Superintendent of the Western Light & Power Company at San Francisco. Following this, he became General Manager of the Peninsula Light & Power Company, Redwood City, California. While filling this position, he

opened engineering offices at San Francisco and began operating as consulting and supervising engineer, supervising the construction of steam and hydro-electric plants along the Pacific Coast, Central America, Hawaiian Islands and Japan.

In 1899 he organized and became Vice-President, Engineer and Managing Director of the Kilbourne & Clark Manufacturing Company of Seattle, Wash., engineering and construction contractors, conducting a commercial electrical business. During the previous years, he had devoted much time to the development of high tensile strength electrical conductors, and in 1904 he was made electrical engineer and manager of the Ansonia Brass & Copper Company, of New York, where he completed the development of high tensile strength, high conductivity cable for use in long distance transmission, the first of these cables being installed at Guanajuato, Mexico, in 1905, on spans averaging 500 feet in length. This was immediately followed by other long span transmission lines, with spans from 600 to 1,700 feet, made possible by the development of this cable.

From 1907 to 1909 Mr. Clark was engaged in research work at Columbia University, where, in cooperation with Professor Herschel C. Parker, he developed a new incandescent electric lamp, using a combination of silicon and carbon as the conducting filament. This lamp operated successfully at 2 1/10 watts per candle power, which was then 1 watt less per candle power than the best carbon filament lamps available; but before the silicon carbon lamp was ready for the market the development of the tungsten lamp, which was capable of operating at a much higher efficiency, stopped the further development of this conductor for use in an incandescent lamp, but the material was further developed and used as a resistor for electrical heating and in electrical instruments under the name of "Helion."

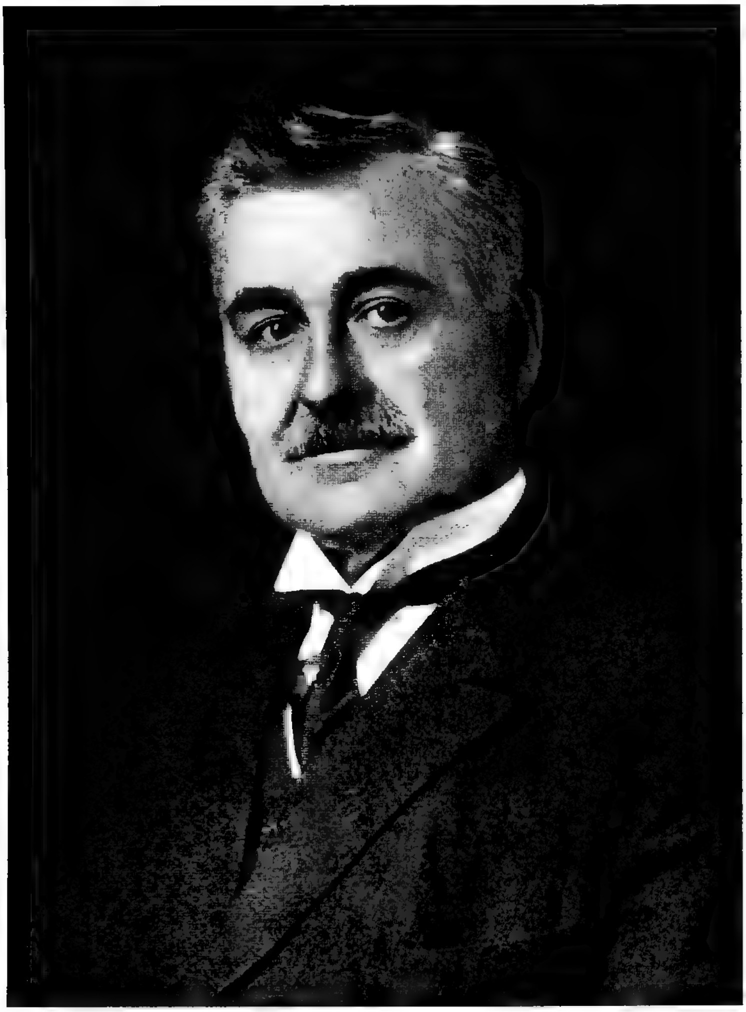
In 1908 he opened engineering offices in New York City, in the Singer Building, 149 Broadway, where he has acted in the capacity of consulting electrical engineer. In 1910 he was made consulting engineer and American representative of the Victoria Falls and Transvaal Power Company, of London and South Africa. He is President of the Clark Electric & Manufacturing Company, of New York; Vice-President of the Kilbourne & Clark Manufacturing Company, of Seattle, Wash.; member of the American Electrochemical Society, Pacific Northwest Society of Engineers, American Institute of Electrical Engineers, American Institute for the Advancement of Science and 32nd degree Mason. His New York clubs are: The Union League, the Engineers' Club, the Faculty Club of Columbia University, the Railroad Club, the Greenwich Country Club, of Greenwich, Conn. Mr. Clark is unmarried and resides at the Engineers' Club, of New York City.

JAMES FULTON CUMMINGS

JAMES FULTON CUMMINGS

James F. Cummings, consulting engineer, had become noted, previous to his untimely death July 26, 1917, as one of the most able electrical and conduit experts, both in the United States and many of the countries of Europe. He was a hard, consistent worker and at all times a student, and this application to his profession soon made him a dominating figure in all things electrical. Mr. Cummings was born in London, Canada, in 1867 and was educated at Tammarack College. He came to the United States at the age of eighteen and secured a position as night operator with the Bell Telephone Company at Detroit. After a short time in this capacity he was made night clerk and then manager of the office, a position he retained for nearly three years. During his term of employment with the Bell Telephone Company he exerted that power of perception and analysis which afterwards brought him success, with the result that he mastered every detail of the business. After becoming thoroughly familiar with the instruments and their operation, he began to perceive points where the service was weak and to offset this he designed several improvements on the telephone switchboard. His success led to a determination to get into the construction end of the business, and in pursuance of this determination he went to the Edison Machine Works as an underground man during the installation of the Detroit plant. From this period he was recognized as one of Mr. Edison's "young men" and was intrusted with most intricate work by that inventor. Upon the completion of the Detroit plant, he was transferred to Columbus, Ohio, as assistant foreman on the Edison underground work. From there he went to Chicago, where he was made assistant superintendent of all underground work then being installed for the Chicago Edison Company. The Marr Construction Company had the contracts for installing the electric machinery and fittings for the Edison station, and Mr. Cummings was transferred to that company and given charge of the station work, including the putting in of all the cables. This was the first thorough experience Mr. Cummings had in central station work and he remained in charge until the plant was running and turned over to the Chicago Edison Company. His next work was in Rochester, N. Y., where he superintended the extension of a feeder line for the Rochester Edison Company, and from there he was transferred to Philadelphia, where he was engaged in construction work for the Philadelphia Edison Company. He was finally made assistant superintendent of all the electrical work in Philadelphia, both interior and underground, and for the station, and after its completion was superintendent and electrical engineer until the plant was turned over to the Philadelphia Edison Company. Mr. Cummings then went to Toronto, Canada, as engineer and superintendent of construction of the Toronto Edison system, which was the first Edison underground plant in Canada. After this work was finished he was transferred to the Engineering Department of the Edison General Electric Company, New York City. He laid the first Edison tubes in Milwaukee and all the feeders for the Milwaukee Street Railway. He was altogether nearly six years with the Edison Company and spent two winters in the testing room of the Edison Machine Works in Schenectady, N. Y., devoting special attention to underground problems. His wide experience in construction and his research work while in the testing room of the Edison Machine Works awakened his thoughts to the possibilities of the underground branch of electric work, both for railways and the general transmission of electrical energy, especially in the line of high tension currents, and he began to devote particular attention to this branch of the service. He designed a complete electric railway conduit system, including a system of distribution that is now embraced in some of the present systems of underground construction. He also devised a complete underground system for the transmission of current with bare copper conductors and he was the first in this country to demonstrate that high potential currents could be taken care of underground in bare conductors. Mr. Cum-

mings spent considerable time in designing an interior conduit system. The result of this was "amorite," an iron tube with a lining of wood for electrical purposes, which took the place of the old style heavy tubing. This tubing could be bent to any position without splitting the interior lining and could be cut so that the interior could be viewed at a point in the curve. Mr. Cummings organized the Cummings & Engleman Company, of Detroit, for the development of these systems, and this firm was later succeeded by the Cummings Conduit Company, of which Mr. Cummings became president. A factory was located in Detroit and a large amount of the Cummings tube was installed in many of the largest office buildings throughout the country. The Niagara Falls Hydraulic Power and Manufacturing Company found the Cummings system of carrying bare wires underground very serviceable and installed it. The service has been continuous night and day for years and is still satisfactory. The factory of the Cummings Conduit Company was eventually removed to Pittsburgh, Pa., where Mr. Cummings sold his interest in the business and devoted his time to other branches of the industry. He installed the first storage battery on the 28th and 29th street line, New York City, and, acting as motorman, piloted the first car over the road. After Mr. Cummings had sold his American interests he removed to London, where he opened a large contracting office as a partner of the firm of Maguire & Baucus, 5 Warwick Court. While abroad, Mr. Cummings was connected with many important underground installations in the United Kingdom and Italy, the most notable of the latter being in Milan and Turin. His greatest achievement along this line, however, was in Russia, where he installed a system in Petrograd, covering the entire city, which attracted wide attention in the technical press and electrical circles of both Europe and America. While a resident of London he was one of the most popular members of the American colony and was noted for his friendliness to, and interest in, all Americans who were temporary residents of the city. In all, Mr. Cummings spent fifteen years in Europe, and upon his return to this country in 1911 he retired from active business. Mr. Cummings' interest in all things electrical and the commercial and scientific development of the industry, is shown by his efforts to make an unqualified success of the electrical show in this country, held at Madison Square Garden in the '90s. Mr. Cummings' father, Alfred A. Cummings, was one of the best known and most highly respected men in Canada. He was born in Edinburgh, Scotland, and, removing to Canada when a young man, soon attracted attention by his poetic contributions. The one by which he is best known and which endeared him to the hearts of all Canadians is, "The Maple Leaf Forever," a national hymn that will stand as a monument to the author as long as the nation lasts. Mr. Cummings' mother was a direct descendant of Robert Fulton, and it is doubtlessly due to the sturdiness of the one ancestor and the inventive genius of the other that Mr. Cummings became possessed of his tenacity and power of discovery. Mr. Cummings was a member of the National Sporting Club of London, the St. Stephens Club of the same city and the New York Athletic Club. His death was from apoplexy while a guest at the Hotel Nassau, Long Beach, and interment was at Battleboro, Vermont, after services at his home, "The Langham," 135 Central Park West. He left a widow, but no children.



WILLIAM J. CLARK

William J. Clark, a pioneer in the commercial development of electric railways throughout the United States, and who obtained the legislative charter authorizing the construction of the first electric railway in the world intended for freight traffic, was born July 29, 1854, in Derby, Connecticut, where he acquired his education at the public schools and in private study, which he still continues. He began his business career in 1868 as a post-office clerk at Birmingham, now Derby. In 1872 he entered the employ of his father and brother, who were in the coal business, becoming a partner three years later and continuing the connection until 1888. He was postmaster of his native city from 1879 until 1888, during which period he was frequently called upon by the Post Office Department to perform important special duties elsewhere. As postmaster he secured for the city the finest equipped, second-class post offices in the United States and succeeded in having a free delivery service established. He also investigated important criminal matters, convicting over one hundred violators of Federal laws. During his tenure of office he shot post-office burglars and was shot at by them. In 1882, at Ansonia, Connecticut, he held up a large mob single handed to rescue a negro who was threat-

ened with lynching by the excited crowd. Acting upon the advice of the late William Wallace, the pioneer of arc lighting and motor production, and attracted by the possibilities presented by electric traction for the betterment and expansion of local transportation facilities, Mr. Clark entered the electric field and participated in the commercial expansion of almost every phase of the Thomson-Houston and General Electric Companies' business throughout the world. In the spring of 1888 he induced the Thomson-Houston Electric Company to purchase the Vandepoele Electric Railway patents, which from the patent standpoint were essential to the fullest possible development of that character, and shortly thereafter making the practical accomplishment of this possible, as well as great expansion by the Thomson-Houston Company, in other directions through securing from the Connecticut Legislature amendments to the special charter under which that company was organized and which had previously restricted its expansion. An immediate result from this feat was a sensational rise in the price of the company's stock from about $150 to over $350 per share.

The pioneering and commercial development of the electric railways throughout the United States necessitated Mr. Clark having the mastery of everything contributory to that great objective, from publicity, organization and finance to legal procedure and practical politics. Early recognition of the great practical value of certain fundamental patented electric inventions, with active work in bringing these under the control of corporate interests represented by Mr. Clark, who subsequently played an important part in their commercial exploitation, were: Sprague's Electric Railway Motor Suspension; Vandepoele's Carbon Commutator Brush; The Pivoted Under-Running Trolley; Potter's Series Parallel Control; Sprague's Multiple Unit Train Control; Curtis' Steam Turbine; various inventions incident to the construction of underground conduit systems for electric railway operation and important pioneering and similar work on the electrification of steam railways, both in this country and abroad. In 1896, at Milwaukee, Mr. Clark made the first in this country of what is now termed "Physical Valuation" of a large electric public utility. This work was highly complimented by the United States Circuit Court, to which it was presented, and the general plan then inaugurated has since been frequently followed by others.

At various periods Mr. Clark has made exhaustive investigations of public utility, manufacturing and commercial situations in this country, Europe and South America, and important negotiations incident thereto, both for the General Electric Company and for prominent banking interests of this country and Europe, as well as for the benefit of the Federal Government.

A trip for the purpose last indicated through Cuba, in 1895, resulted in important work for the War Department in 1898, incident to which was the nursing of the late Colonel Waring during his last illness with yellow fever and the elaboration of his notes on the "Sanitation of Havana," which permitted their subsequent utilization, also the writing of Mr. Clark's book, "Commercial Cuba," in 1898. Mr. Clark was in charge of the bureau which secured the reopening of the Knickerbocker Trust Company in the latter part of 1907 and the first part of 1908.

The feature in his whole career which has been most satisfactory to him has been the selection and training of many promising young men, some of whom today occupy most important positions both with the General Electric Company and elsewhere in the electrical industry, or who have become wealthy and retired.

Mr. Clark has been continuously connected with the same corporate interests since March 28, 1888, during which time he filled the following positions, on occasions holding two or more at the same time: General Agent, Railway Department, Thomson-Houston Electric Company; Managing Director, British Thomson-Houston Company, Ltd.; General Agent Railway Department, Manager Cincinnati Office, Manager Railway Department, Manager Foreign Department, Manager of the London Office, and for the General Electric Company, of which he is at present manager of the Traction Department, with offices at 120 Broadway.

In 1898 Mr. Clark was Expert on Cuban Affairs for War Department, which position brought him in close touch with the Secretary of War during the period of the Spanish-American War. In 1906 and 1907 he was Chairman of the Ways and Means Committee of the National Civic Federation, in which connection he financed the extensive investigations of municipal ownership conducted by the Federation in this country and in Europe, and was also a member of the Commission which made the investigation. He was also connected with the Republican National Committee in the campaigns of 1880, 1884, 1896 and 1904.

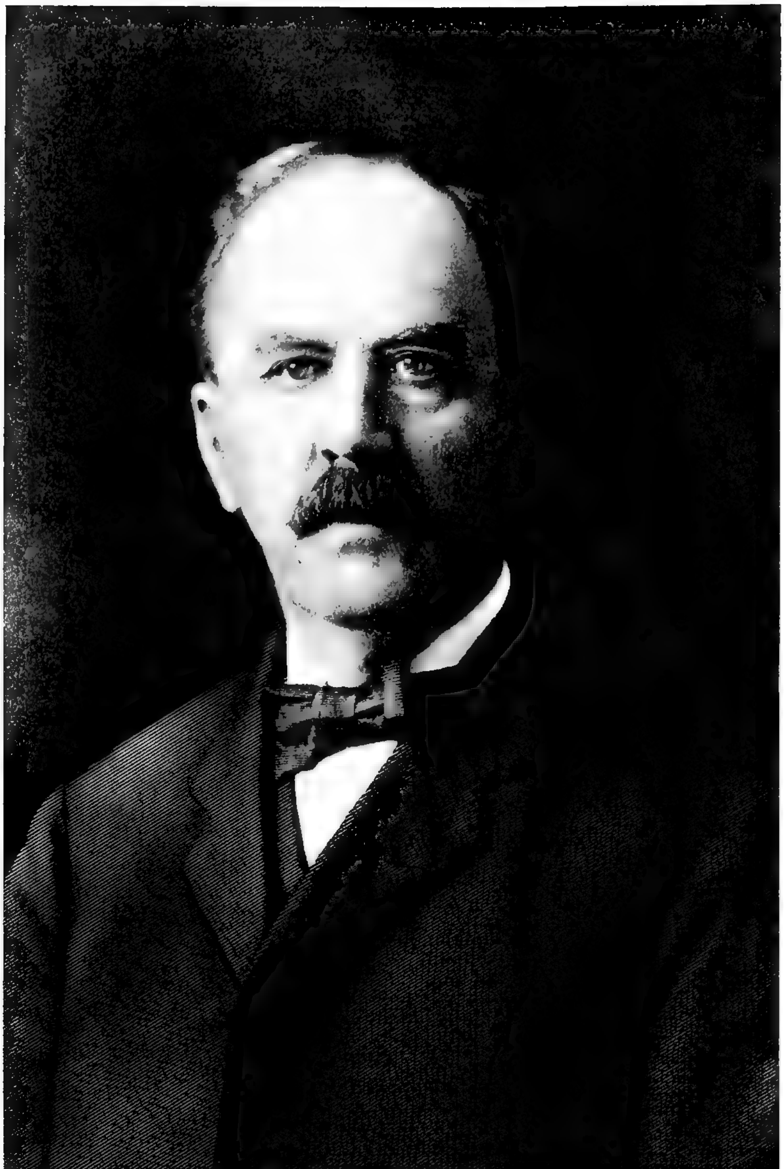
Mr. Clark is a Fellow of the American Institute of Electrical Engineers, American Electro-Chemical Society, American Economic Association, American Academy of Political and Social Science, New York Electrical Society, American Electric Railway Association, National Electric Light Association, British Light, Railway & Tramway Association; Bankers' Club, Railroad Club, New York Railroad Club, Engineers' Club, Mohawk Golf Club and Mohawk Club, Schenectady, N. Y.; Masonic Fraternity, Scottish Rite, Mystic Shrine, Elks, and Jovians. He resides at 255 West 90th Street, New York City.

ROBERT B. COREY*

After a preparatory education at the Elmira Free Academy, Elmira, N. Y., Robert Corey entered Yale University, class of '82, but left before graduating to join his father, who was in the banking business in Bradford, Pa. He was born in Elmira, July 2, 1861, and after being engaged for some years in financial pursuits, he became, in 1889, general manager of the Electric Construction Supply Company. He remained in this capacity until 1896, when he organized the R. B. Corey Co., dealers in electric appliances and supplies. While general manager of the Electric Construction & Supply Co., Mr. Corey was instrumental in developing the arc lamp for constant potential circuit, two in series on 110 volt. The electrician of the company at that time was B. B. Ward, and the Ward Arc Lamp was developed, many thousands of which were sold to the Edison lighting companies throughout the United States. About 4,000 were in use on the circuits of the New York Edison Company, and a similar number on the circuits of the Brooklyn Edison Company. The Ward arc lamp was the first of its character, and afforded the Edison lighting companies a chance to strengthen themselves as against the high-tension lighting companies. Mr. Corey is a member of the Engineers' and Machinery Clubs. In addition to his interest in the R. B. Corey Company, he is president of the American Kron Scale Company. His business address is 39 Cortland street.

*Mr. Corey died October 7th, 1918, at his home in Plainfield, N. J.

ROBERT B. COREY
(deceased)



JOHN B. CROUSE

JOHN B. CROUSE

In John B. Crouse Cleveland has a citizen who has achieved an enviable prominence in the industrial world. Following a course unique in its far-sighted purpose and results, he has been active in the movement to annihilate competition through cooperation, and to put into the business world as a practical asset that energy which was previously dissipated in efforts to build up one business at the sacrifice of another.

Mr. Crouse was born November 29, 1842, in Hartland, Michigan, and after attending the common schools was graduated from the High School of Ann Arbor, Michigan. He then turned his attention to general merchandizing and also became connected with the milling business in Highland. Gradually he extended the scope of his activities, recognizing and utilizing every legitimate opportunity to further his interests. He early asociated with H. A. Tremaine in the establishment and conduct of a pickle and vinegar factory an association which has been maintained ever since in other and more extensive enterprises. They went to Cleveland in the '80s and there established business under the name of the Cleveland Carbon Company, later merging with the Bolton & Crystal Carbon Company, forming the Standard Carbon Company, Mr. Crouse being at the head of the sales department. Later controlling interest in the latter company was sold to the National Carbon Company. Mr. Crouse continued in active business with H. A. Tremaine, going to Fostoria, Ohio, where they conducted business under the style of the Crouse & Tremaine Carbon Company. Later they sold a half interest in this company also to the National Carbon Company and continued to operate the plant. Mr. Crouse in company with H. A. Tremaine, B. G. Tremaine, R. Crocker and Ira Cadwalder, organized the Seneca Banking Company at Fostoria, Ohio, also the Fostoria Incandescent Lamp Company, Mr. Crouse becoming president of the latter. The partners in those enterprises soon afterward purchased the Fostoria Bulb & Bottle Company, changing the name of the plant to the Fostoria Glass Specialty Company. The output of this factory was largely used by them in the incandescent lamp business.

Continually studying for new methods to improve their business, to extend trade and to meet competition, J. B. Crouse, H. A. Tremaine, J. R. Crouse, F. S. Terry and B. G. Tremaine, after many discussions of the problems and questions that confronted them in manufacturing lines, conceived the idea of concentrating the lamp business of the country, with the result that the National Electric Lamp Association was formed, which is today one of the most remarkable business organizations in the country. America is fast coming to realize that the greatest success and prosperity are to be found in cooperation; which cooperation must exist not only among manufacturing interests, but must extend from the manufacturer to his distributor and thence to the ultimate consumer. Interest has been keenly directed to the broad-gauge policy of cooperation instituted and maintained by the National Electric Lamp Association. For years before its organization there had been bitter warfare between lamp manufacturers, and competition was so pronounced that in order to make sales, various companies were sacrificing quality, a fact the public came to realize, and it demanded a return to the former and higher standard. Understanding the conditions, several of the prominent lamp manufacturers decided to unite upon a standard of quality and, as stated, Mr. Crouse, H. A. Tremaine, J. R. Crouse, F. S. Terry and B. G. Tremaine organized the National Electric Lamp Association. The first step in this direction was a mutual engineering department and the laboratories were established and an organization perfected in Cleveland, that city being the natural center of the industry. Many thought the movement a visionary, impractical scheme, but as the broad-minded, enterprising business men came together they found that mutual understanding and cooperation would be most beneficial, and soon widened the scope of their cooperative effort until it embraced sections in chemical and physical research, testing, factory inspection and organization, illuminating engineering, technical publicity, business development

and managerial and sales conferences. For the betterment of the trade in general the association established in Cleveland a physical laboratory, operating at a cost of twenty-five thousand dollars a year, exclusive of equipment. Here scientists of recognized standing are undertaking advanced investigations in the field of light and illumination. The association has also established a school of electrical illuminating engineering, from which one hundred or more technical graduates are entered for training. The plan is continuous, each year a new student body enters, the graduates being absorbed by the various companies forming the organization. The standard of admission is high and the curriculum comprehensive along both theoretical and practical lines, the leading technical schools of the country being drawn upon for students.

Today the National Electrical Lamp Association has a membership of twenty-three companies, manufacturing about fifty per cent of the total number of incandescent lamps used. Every question involved in the manufacture of four hundred and thirty-five sizes, styles and types of incandescent lamps is discussed by the association. Advanced research and test work is carried on by the association whereby each member company knows the quality of its product from month to month, and tests are made as often as any company may request. It was found that variation in quality was often due to the chemicals and raw material used in manufacture, and one direct result of the association's move has been an improvement in such raw materials, the dealers coming to understand that member companies of the association will accept only such as will stand a test made by their engineering department. A cooperative feature of the work of this department is that of supplying superintendents or skilled assistants to any member company that may need them. There is also a commercial engineering department which prepares and publishes bulletins, pamphlets and articles on subjects broadly devoted to illuminating engineering. The bulletins of the association are regularly accepted by central stations, illuminating, engineers and even by leading schools and colleges as authority as they are kept free of commercial bias and the data contained therein has stood critical inspection of scientific men.

The cooperative spirit is fostered and furthered and in fact, largely has its root in the semi-annual meetings which are held on an island of sixty-five acres in Lake Ontario near Sackett's harbor. There is maintained a well equipped camp, the tents all being supplied with electric light and running water; there are tennis courts, a handball court, a common, a bathing beach, bowling alleys and boathouses. Here men meet in social intercourse, resulting in many life long friendships. There are days which are given over only to outdoor sports, but there is another side to this camp; intimacy. Each man learns how the other thinks and feels, each learns to appreciate the other's good points and to forgive faults. This personal relation is undoubtedly one of the strongest elements in the success of the association, doing away with the feeling of warfare and contest that existed between hitherto rival manufacturers. The members have come to know that they must give and take, that the ideas and plans of one company may be of benefit to another and that the upbuilding of the trade will react in favor of all. To his duties in connection with this association Mr. Crouse is devoting much attention and at the same time is superintending his private interests. In addition to his previously mentioned connections he is also vice president of the Cleveland Gas & Electric Fixture Company.

Mr. Crouse has converted the old homestead farm at Hartland, Michigan, into one of the most modern and up-to-date dairy farms in the country, on which he has built a barn after his own ideas of modern construction, embodying all the latest sanitary features. The floors, mangers and feed troughs are of cement, while the stanchions and partitions are of iron. The utmost regard is paid to cleanliness and sanitary conditions. The milking is done by machinery, one man milking sixty cows. Although Mr. Crouse has invested many thousands of dollars in this, he takes great pride in conducting it upon a paying basis. The herd consists entirely of Jersey cows, and the butter is marketed under the

J. ROBERT CROUSE

name of Crouse's Jersey Creamery Butter and is regarded as the standard of excellence in the market where it is sold. The plant has a capacity of four thousand pounds of butter each week and consumes the cream purchased from neighboring farmers as well. It is characteristic of Mr. Crouse to succeed in everything that he undertakes and he has done this in the conduct of the dairy farm as well as in the commercial and industrial interests of magnitude to which he gives his attention.

At Hartland, Michigan, in 1864, Mr. Crouse was united in marriage to Miss Betsey Westfall and they had one son, J. Robert, who was graduated from the Central High School of Cleveland in 1893 and from the University of Michigan in 1897, since which time he has been his father's intimate associate and partner in business enterprises. The mother died in 1893 and in 1900 Mr. Crouse wedded Mrs. Edith May Avery, of Stockbridge, Michigan. Mr. Crouse is a thirty-second degree Mason, belongs to Al Koran Temple of the Mystic Shrine and has many pleasant social relations of other characters.

J. ROBERT CROUSE

Though science is the foundation and invention the creative force which has so expanded the known uses of electricity as a contributor to human comfort and industry, it is, after all, salesmanship which gives to the inventions access to commercial rewards which encourage further invention and larger efficiency. In the manufacturing branch the sales department figures largely in the creation of success.

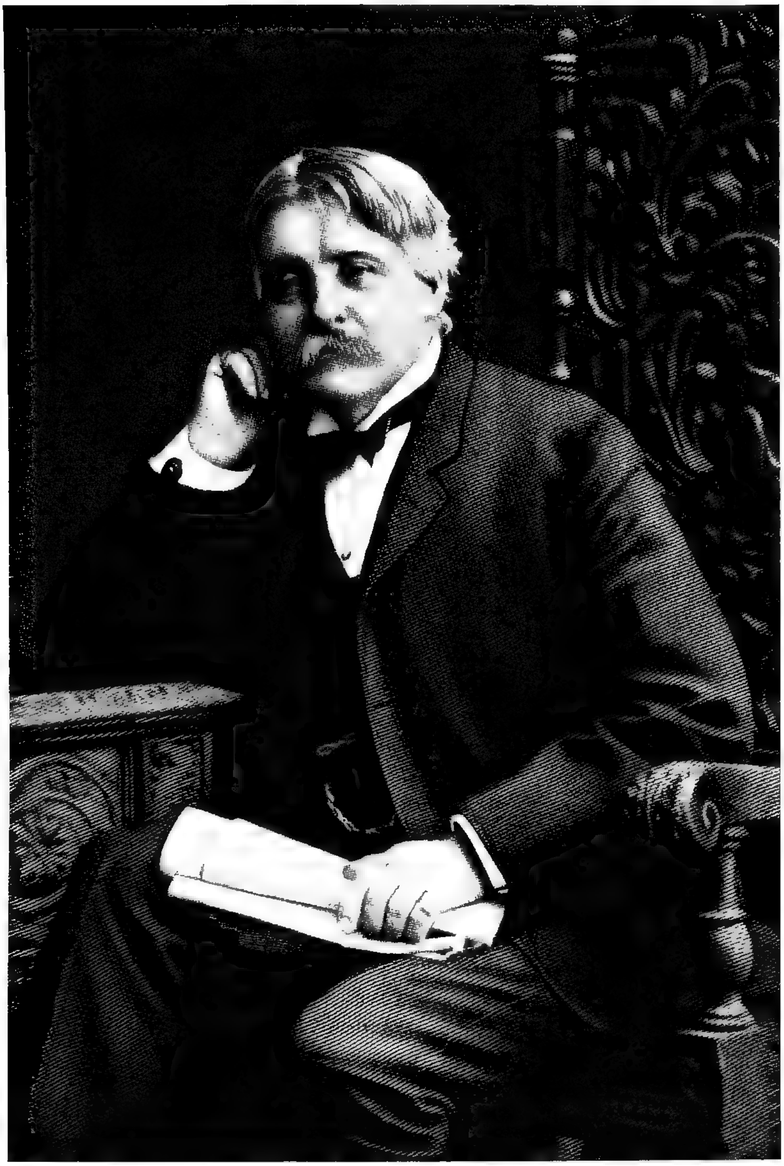
Of national prominence in electrical salesmanship is Mr. J. Robert Crouse, who has spent his entire life in the sales branch of the incandescent lamp business, coming into it with a hereditary predisposition to sales work. He was born January 1, 1874, and was graduated from the University of Michigan with the degree of A.B. in the Class of 1897, becoming a member of the Delta Upsilon while at college. His father, J. B. Crouse, and his uncle, H. A. Tremaine, were identified with the electric light carbon business in its inception, and he naturally came in on their later and more extended operations. He began his active business life as a salesman of the Fostoria Incandescent Lamp Company, of Fostoria, Ohio, and advanced in the service of that company to the position of sales manager. Under the same proprietorship were the Crouse-Tremaine Carbon Company, the Fostoria Bulb Company and the Seneca Banking Company, all of Fostoria, Ohio, the operations of these companies, in 1901, aggregating about $2,000,000. In 1901 his father, J. B. Crouse, and associates, H. A. Tremaine, B. G. Tremaine, F. S. Terry and J. Robert Crouse, organized the National Lamp Company, of which Mr. J. Robert Crouse became Vice-president and Sales Manager, and he was also Vice-president of the Crouse-Tremaine Company, organized in 1907. The National Lamp Company's works in Cleveland, Ohio, became a factor of great prominence in the development of electrical lighting upon a large commercial scale and in its development Mr. Crouse took a prominent part. In 1911 the business was sold to the General Electric Company, and has since been conducted as the National Lamp Works of the General Electric Company. Mr. Crouse continues as Vice-president of the Crouse-Tremaine Company. Mr. Crouse founded the Electrical League of Cleveland, Ohio, of which he is a prominent member, and was the Seventh Jupiter of the Jovian Order, is a member of the National Electric Light Association, the Illuminating Engineers' Society, and the Electrical Manufacturing Club. He is a member of the Cleveland Chamber of Commerce, and vice-chairman of its Industrial Development Committee, is vice-president of the Society of Electrical Development and is a member of the Union Club (Cleveland), the Shaker Hakes Country Club, Cleveland Athletic Club, and Cleveland Automobile Club. He has been especially active recently as director of Red Cross work among elec-

trical men in Cleveland and has achieved a notable degree of success in that work. Through the various societies in which he has membership, and close business association with leaders in electrical affairs, Mr. Crouse has been actively prominent as an advocate of coöperation of the efforts of those in the electrical business to increase the use of electricity in all established ways and in many others to which it is applicable and to promote a general propaganda of the uses, applications and benefits of doing things electrically.

Largely as the result of the efforts of Mr. Crouse, whose adherence to this campaign of publicity included many articles in the technical press and the proceedings of electrical societies, the Society of Electrical Development was incorporated under the laws of the State of New York, to which all engaged in electrical business whether as dealer, manufacturer, contractor or the management of the central stations are eligible. It was formed to promote and increase the use by the public of the electric current for all useful purposes as an end in itself and as a means of increasing the demand for apparatus and supplies, and to promote and facilitate a coöperative planning and execution of various means and methods effective to this end. The plans and purposes of the Society extend to a very earnest endeavor to secure harmony of effort in promoting the greatest possible development of electrical science, art and industry, both technical and commercial; to develop means and methods tending to promote the welfare of individuals identified with all branches of the business. Mr. Crouse in an address delivered at Camp Coöperation held at Association Island in 1913 set forth in a convincing way the value of such coöperation.

ALBERT BROWN CHANDLER

Albert Brown Chandler, former President of the Postal Telegraph Cable Company, has had a varied and interesting career during his long life of business activity, rising from a printer and compositor to the presidency of a powerful corporation and filling, in the interim, various positions in the railway service and as a Government attache during the Civil War. Mr. Chandler was born in West Randolph, Vermont, August 20, 1840, a descendant of the family of Chandlers, the American branch of which was established by William Chandler and his three sons who settled in Roxbury, Massachusetts, in 1637. Among the descendants of these early settlers were Senator Zachariah Chandler, Senator William E. Chandler, Commander Benjamin F. Chandler, U. S. N., and Professor Charles F. Chandler of Columbia University. After attending school in West Randolph, Vermont, during which period his vacations were spent in learning the printing art and working as a compositor, Mr. Chandler finally studied telegraphy while working as a messenger in the local office and was appointed manager of the Western Union Telegraph office at Bellaire, Ohio, in 1858. The following year he was made agent of the Cleveland & Pittsburgh Railroad at Manchester, Pennsylvania, and in May 1863, he was assigned to duty as Cipher Telegraph Operator in the War Department at Washington. In October of the same year he became Disbursing Clerk for General Eckert, who was then Superintendent of Military Telegraph in the Department of the Potomac, dealing directly with President Lincoln. This was in addition to his duties as Cipher Operator, and in August 1866, he was made Chief Clerk in the office of the General Superintendent of the Eastern Division of the Western Union Telegraph Company, having in charge the trans-Atlantic and Cuba cable traffic. In addition to this position, he was appointed Superintendent of the Sixth District of the Eastern Division of the company, resigning to accept the position of Assistant General Manager of the Atlantic & Pacific Telegraph Company, of which General Eckert was then President, in 1875. He successively filled the positions of Secretary, Treasurer and vice-President, and in 1879 succeeded General Eckert as President. After the company was combined with the Western Union in 1881,



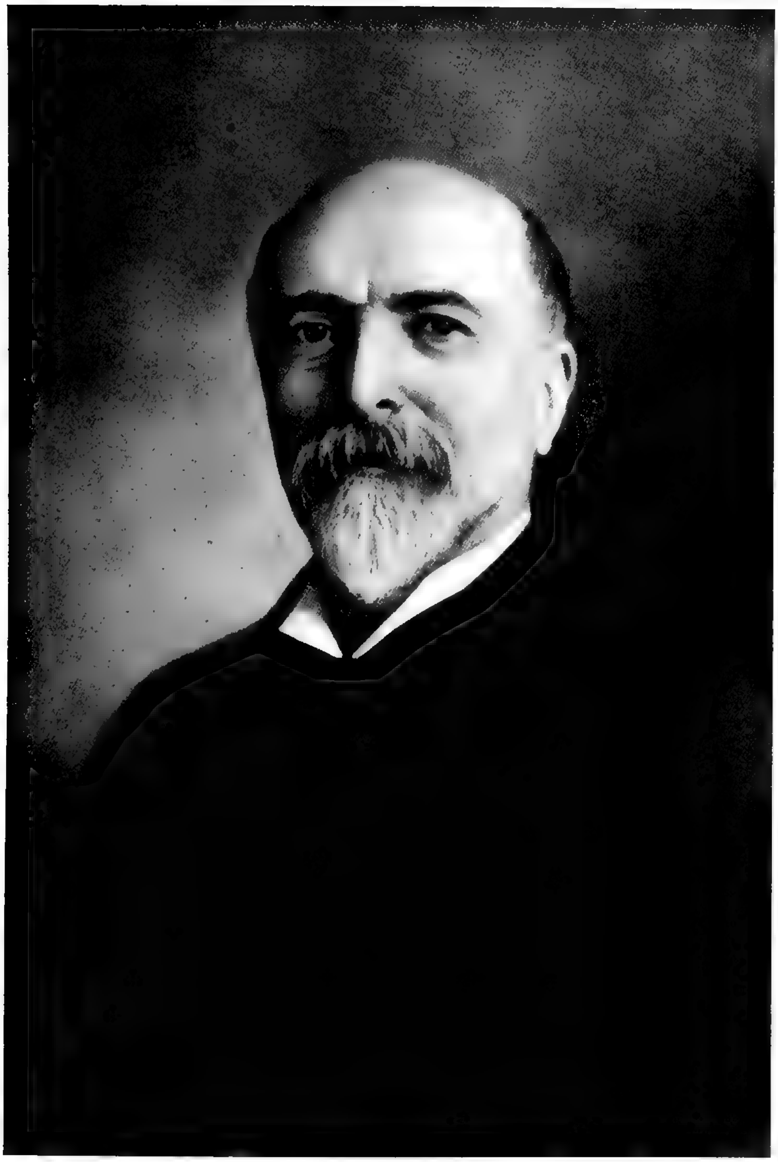
ALBERT B. CHANDLER

Mr. Chandler became President of the Fuller Electrical Company, which was one of the first to develop the arc system of electric lighting. In December, 1884, he became counsel for the Postal Telegraph Company, and one year later was appointed Receiver of that company. He succeeded in reorganizing the company and became its President and General Manager in 1886, at the same time serving as a member of the Executive Committee and vice-President of the Commercial Cable Company. He was made acting President of the Pacific Postal Telegraph lines, when they were constructed, and in March, 1887, became a director and soon afterwards President of the Commercial Telegram Company, a local organization engaged in reporting transactions of the stock exchange. This property was acquired by the New York Stock Exchange in 1890, and Mr. Chandler was in charge of its

operation from 1890 to 1915. In 1887, in connection with several officials of the Western Union Company, Mr. Chandler effected arrangements for the discontinuance of the previously existing wasteful telegraph competition, the result of which was the reduction of rates, the abolition of rebates and better service for the public. The fine building of the Postal Telegraph Company, at Broadway and Murray Street, was erected under Mr. Chandler's supervision and when he finally retired from the Presidency of that company he was induced to continue in close relations with the management as Chairman of the Board of Directors. After occupying this position for some years he retired from business, completing one of the most active careers in the history of telegraph. Mr. Chandler has been a director or official of several financial and commercial companies in which he has always taken a deep interest. He was married October 11, 1864, to Marilla Eunice Stedman, of West Randolph, Vermont, the union bringing three children, Florence, Albert Eckert, and Willis Derwin, of whom only Albert Eckert survives. His wife, Marilla, died September 14, 1907. On December 13, 1910, he married Mildred Vivian of New York City. They reside at 389 Clinton Avenue, Brooklyn, New York, and also have a handsome summer home at Randolph, Vermont.

COL. ROBERT C. CLOWRY

Col. Robert C. Clowry, who has been for over half a century one of the best known and most active figures in the field of telegraphy, was born on a farm in Illinois, September 8th, 1838. He was educated in the schools in the district where he was born, and, taking a great interest in telegraphy, then in its infancy, he determined to become a telegraph operator. He served six months as a messenger boy at Joliet, Illinois, without pay, for the privilege of learning the business. After mastering all the details he was given a responsible position as manager with the Illinois & Mississippi Telegraph Company at Lockport, Illinois, when only fourteen years of age. This was in 1852. After a short period of service at Lockport he was transferred to Springfield, Illinois, where, in 1853, at the age of sixteen, he was employed as manager of the office. He was later transferred to St. Louis, Mo., and, after filling various positions in that office, he was, at the age of twenty-one, appointed to the position of Superintendent of the St. Louis & Missouri River Telegraph Company and later to the position of Superintendent of the Missouri & Western Telegraph Company. He was afterwards located at Leavenworth, Kansas, and Omaha, Nebraska. During the time he was located at Springfield, Illinois, he became acquainted with Abraham Lincoln, who at that time was engaged in the practice of law. Following Mr. Lincoln's election to the Presidency and the breaking out of the civil war, he commissioned Mr. Clowry Captain and Assistant Quartermaster and assigned him to duty in charge of the military telegraph service in the Southwest. Capt. Clowry also served the Government at Little Rock, Ark., and St. Louis, Mo., and was brevetted Lieutenant-Colonel by President Johnson, who commended him "for meritorious service and devoted application to duty." Col. Clowry was mustered out of service May 31st, 1866, and was immediately appointed District Superintendent of the Western Union Telegraph Company, in charge of the lines in the Southwest, with headquarters at St. Louis. He was made Assistant General Superintendent of the Western Union Company at Chicago in 1879, and two years later succeeded General Anson Stager as General Superintendent. In this position he was in complete control of all of the company's lines west of Pennsylvania, north of the Ohio River and west of the Mississippi River to the Pacific Coast. In 1885 he was elected to the directorate of the Western Union Company, a member of the executive committee, and Vice-President, still retaining the position of General Superintendent. In 1902 he was elected President and General Manager of the Company. During all of these years of



COL. ROBERT C. CLOWRY

successive promotions, Col. Clowry attained recognition as the foremost authority in the field he had selected as his life work in early boyhood. He had reached the highest pinnacle in the field of telegraphy, and, in addition to the presidency of the Western Union Company, he was the executive head of numerous auxiliary telegraph, cable and telephone companies of the Western Union Company and a director in various other companies. Col. Clowry retired from active participation in business affairs some time ago, but still maintains an office at 30 Church Street, New York, for the conduct of his private interests. At the present time he is a director of the Dominion Telegraph Company, the Texas & Pacific Railway Company, the Western Union Telegraph Company, and is a trustee of the Equitable Trust Company of New York. He holds membership in the Metropolitan, Lotos, Railroad, Sleepy Hollow Country, and Ardsley Clubs of New York and vicinity; the Chicago Club and the Commercial Club of Chicago, and the Jekyl Island Club at Jekyl Island, Georgia. He was married in 1865 to Caroline Augusta Estabrook of Omaha, Nebraska, the daughter of General Experience Estabrook, who was the first United States District Attorney for the territory of Nebraska. Mrs. Clowry died in 1897. Col. Clowry's residence is at Tarrytown, New York.

ALFRED HUTCHINSON COWLES

Alfred Hutchinson Cowles, inventor of the electric process for reducing aluminum from alumina by which that metal, formerly expensive, was made available for the production of goods in common use, was born in Cleveland, Ohio, December 8, 1858, a son of Edwin Cowles, founder, owner and editor of The Cleveland Leader and Evening News, later The News and Herald, and descendant of John Cowles, a settler of Farmington, Mass., 1636, and also of Thomas Hooper.

After two years at Ohio State University and four years at Cornell University, specializing in physics, chemistry and other science studies, he, with his brother, Eugene H. Cowles, engaged in developing ore lands in New Mexico, the ores of which were unresponsive to ordinary reduction processes, to remedy which they designed an electric furnace to volatilize and recover the zinc from the ore in 1884. He then followed this up by experiments which resulted in processes for successful commercial reduction of various metallic oxides by pyro-electric treatment, which the Cowles brothers patented, and by purchasing the rights of Charles S. Bradley, who had applied for a patent germane to their own invention, they secured sole control of electric processes for producing aluminum commercially. Litigation followed, the results of which fully sustained the validity and priority of their patents and secured them royalties and damages from the Aluminum Company of America of $1,300,000, and $300,000 from the Carborundum Company, for infringement.

Many industries to which their patented treatment applied were established and paid royalties, and their own great plant at Lockport, N. Y., now known as The Electric Smelting and Aluminum Company, was originally completed in 1886, Mr. Alfred H. Cowles being its metallurgist for eight years, and after that President of the Company. He is also President of the Pecos Copper Company, owning the original New Mexico lands and now under large development by Goodrich, Lockhart Co., with promise of becoming one of the great mines of the world. He is also President of the Weiller Manufacturing Company.

The Cowles brothers were awarded for their invention the John Scott Legacy medal and the Elliott Cresson medal by the Franklin Institute of Philadelphia. As the result of it, many valuable and useful articles are available at greatly reduced cost.

Mr. Cowles is a fellow of the American Institute of Electrical Engineers; a founder and past Vice-President of the American Electrochemical Society; a founder member of the Mining and Metallurgical Society of America; and is a member of the American Association for the Advancement of Science, the United States Naval Institute, the Franklin Institute and the American Chemical Society.

WALTER CARY

WALTER CARY

The electrical industries, like all others involving complex problems of mechanism in the products they have to sell, have their commercial as well as their technical side, but belong to the highly specialized class in which a considerable amount of technical knowledge is required to be possessed by those in administrative as well as by those in technical authority. This is especially true of the electrical field, where the expert of yesterday is no longer expert unless he is abreast of today's progress and current problems.

There are certain great electrical manufacturing corporations that have gained and maintained prominence in the industry, and in which their position of successful mastery may be in large measure traced to the fact that their administrative officers, as well as the heads of their engineering departments, combine technical and scientific attainments with executive ability. The Westinghouse Electric and Manufacturing Company is prominent among those great concerns which have been consistent in placing in executive positions men of electrical as well as administrative equipment. Among the illustrations of this policy was the election, on June 20, 1917, of Walter Cary to the position of a vice-president of the Company. Years of activity in the field of electrical illumination have made Mr. Cary known to electrical men in all sections of the country, and his election to his present position was an important additional step upward in his always progressive career of twenty-four years in connection with the electrical industry.

He was born in Milwaukee, Wisconsin, on April 26, 1871; was educated at the Milwaukee High School and at Harvard University, from which he was graduated with the degree of A.B. in the Class of 1893.

Soon after graduation from the university he was induced by Mr. George Gibbs to associate himself with the Gibbs Electric Company, of Milwaukee, with which he served as secretary from 1894 to 1898. This introduced him to the electrical industry, which he found congenial, and he fitted himself, by intensive study of both the technical and administrative principles of the industry, for further progress in it. Early in 1899 he associated himself, with some other Milwaukeans, in the organization of the Milwaukee Electric Company for the manufacture of dynamos and motors, becoming its vice-president on organization and its president in 1902. That company, under his energetic administration, became an important factor in its branch of the electrical industry, and in the development and improvement of electrical machinery. He remained with it as president until 1904, when he was called into service with the Westinghouse Lamp Company, of which he soon became vice-president and general manager, a position which he has held ever since. The importance of the service rendered by this company to the marked improvement that has taken place in the field of incandescent lighting during the eighteen years that Mr. Cary has held his executive connection with it is, in large measure, due to his personal initiative, which has at all times been exerted along lines of advancement. Under his active management the Westinghouse Lamp Company has attained and retained its eminent place in the incandescent lighting field.

To translate Mr. Cary's abilities to a larger field he was honored by election to a vice-presidency in the Westinghouse Electric and Manufacturing Company, while still retaining his responsible place as vice-president of the Westinghouse Lamp Company. The Westinghouse aggregation, covering the entire field of electric manufactures, has attained its greatness by its well-defined policy of testing and training exceptional men for executive positions, and its higher officials, chosen on that basis, are all men who have made their mark in the electrical industry.

Mr. Cary has been especially active in the affairs of the Electrical Manufacturers' Club, having served as its secretary for five years, as vice-president one year, and for one year as president of the club.

He is a member of the American Institute of Electrical Engineers, and he is also a member of the Harvard Club of New York City, and also of the University Club and the Union Club of New York.

MAURICE COSTER

Maurice Coster, Managing Director of the Westinghouse Electric Export Company, was born in 1856. He graduated from Stevens Institute of Technology with degree of Mechanical Engineer in 1877, and entered the employ of the Westinghouse Electric & Manufacturing Company in 1888. Mr. Coster was Honorary Consulting Engineer to the Commissioner-General of the United States to the Universal International Exposition at Paris in 1900. He is a member of the National Foreign Trade Council, Director of the Remington Typewriter Co., Fellow of the American Institute of Electrical Engineers, Member of the American Society of Mechanical Engineers, and the following clubs: Automobile Club de France, University (New York), University (Pittsburgh), Engineers, India House and Englewood Country Club.

LOUIS K. COMSTOCK

LOUIS KOSSUTH COMSTOCK

Louis Kossuth Comstock, one of the foremost electrical and mechanical engineers in the country, and a pioneer in adapting wiring systems (or electrical distribution at an even drop in potential) to the modern skyscraper, has for years been engaged in some of the most important electrical work throughout the United States. He was born in Kenosha, Wisconsin, January 8, 1865, the son of Charles Henry and Mercy Carolyn (Bronson) Comstock. After thorough preparation, he entered the University of Michigan, from which he was graduated in 1888, with the Ph.B. degree. Immediately upon receiving his degree, he began his business career in Chicago as a salesman for Sprague motors. The following year he was associated with the Marr Construction Co., afterwards the North American Construction Co. in Columbus, Ohio, as engineer in charge of testing the Edison underground tube system.

Mr. Comstock often tells that he drifted into electrical work because he thought he had been somewhat prepared for it by his college training, but found that he was not. He, however, recognized the possibilities of the electrical field and burned the midnight oil and applied himself to the hardest and most grinding work to fit himself for the career he had selected. The result was the acquirement of a comprehensive knowledge of electrical practice and recognition in the electrical world as one of the foremost men in the profession.

Mr. Comstock's practical experience has been wide and valuable. He was for three years superintendent of construction for the Western Electric Co., and for four years electrical and mechanical engineer for George A. Fuller & Co., of New York City. In each of these positions he was constantly improving upon old methods of wiring and installation until January 1, 1904, when he decided to use his advanced ideas for his own benefit and organized the firm of L. K. Comstock & Co., of which he became president. The firm has become one of the most successful in its line in the country.

Mr. Comstock comes of old New England ancestry of English extraction. On the paternal side he is descended from William Comstock, who settled in Pequa, now New London, Conn., in 1637. Through his grandmother, Mary Doan Bronson, his first maternal forebear in America was John Done, who came to this country in 1620 with his friends Myles Standish and Edward Wynslow.

Mr. Comstock has been an extensive traveller and during his tours has visited the West Indies, Mexico and Central and South America. He is a member of the American Society of Mechanical Engineers, the Electrochemical Society, the Illuminating Engineers, the Japan Society, the Delta Kappa Epsilon Association of New York, the Lawyers' Club, Engineers' Club, Lotos Club, Railroad Club, University of Chicago Club and a Fellow of the American Institute of Electrical Engineers. He was married in New York City, September 12, 1902, to Anne Stevens Wilson, and is the father of one son, Thomas Brownell Comstock, born in 1904. Mr. Comstock's offices are at 30 Church Street, New York City.

CHARLES S. COOK

On March 1, 1917, Charles S. Cook became general manager of the Duquesne Light Company of Pittsburgh, succeeding Robert S. Orr, deceased.

Mr. Cook was born in Amherst, Mass., and graduated from the Worcester Polytechnic Institute. He became connected with the Westinghouse Electric & Manufacturing Company in 1887, when the company was developing the alternating current system of distribution. He served with them in their first manufacturing plant at Garrison Alley until 1888, when he became a construction engineer. In 1889 he was made construction engineer of the Chicago office. In 1891 he became identified with the commercial department of the Westinghouse Company. In 1895 he returned to Pittsburgh to take up special engineering sales work. From 1899 to 1904 he was manager of the Pittsburgh office of the Westinghouse Company. In 1904 he became manager of the Railway and Lighting Department of the Westinghouse Organization, having control of the commercial relations of the company on all business relating to power machinery for public service corporations, which connection was only severed when he left the Westinghouse Organization to take up the duties of his present office.

SEARS B. CONDIT, JR.

SEARS B. CONDIT, JR.

As a representative of both the manufacturing and the selling branches of the business in electrical machines, devices and specialties Mr. Sears B. Condit, Jr., by long experience and important connections in the industry, has become widely known in the electrical world. Today he is at the head of two important enterprises in Boston engaged in extensive activities of electrical production and distribution.

He was born in Somerville, Mass., February 7, 1872, and received his education at the Luther V. Bell School in that city, from which he was graduated in 1887. In 1888 he entered upon his business career in the employ of the Boston Heating Company. This was a corporation which was organized for the purpose of establishing a central heating plant from which to furnish heat to the prominent office buildings of the down-town district of Boston. In the list of the officers and incorporators of that company were many men since prominent in electrical interests, some of the best-known being Messrs. Theodore N. Vail, Calvin A. Richards, Jasper A. Keller, and Frank A. Houston.

After about two years' connection with that company Mr. Condit had an opportunity to connect himself with an enterprise which placed him in close touch with the electrical machinery business, in an offer, which he accepted in 1890, of a position with the firm of Howard & Stone, who were then the New England agents for the C. & C. Motor Company, manufacturers of dynamos, motors and other electrical machinery. Later, through the solicitation of Mr. Harvey L. Lufkin, general sales manager of the C. & C. Motor Company, Mr. Condit accepted a position in the factory of the C. & C. Motor Company in New York City. In that connection he widened his knowledge of the electrical machinery industry and laid the foundations of the larger activities and higher relations to the electrical business which afterward came to him.

In the early part of 1894 Mr. Condit returned to Boston and took charge of the experimental department of Stone & Webster, which was then operated under the firm name of L. A. Chase & Company. He successfully developed that business which was later consolidated with the Shawmut Fuse Wire Company under the name of the Chase-Shawmut Company.

In August, 1899, Mr. Condit engaged in business under the name of S. B. Condit, Jr. & Company as a manufacturer of an extensive line of electrical specialties. These specialties were later taken over by the Condit Electrical Manufacturing Company, while S. B. Condit, Jr. & Company continued to represent some of the most prominent manufacturers of electrical supplies in New England as sales representative. The business has prospered continuously under the personal executive direction of Mr. Condit, whose long experience and thorough knowledge of the electrical supply business has brought wide acquaintance with dealers, engineers and contractors, and an intimate knowledge of their needs.

Mr. Condit has always taken great interest in the many and rapid developments of electricity in application to new industries and the amplified needs of this age. The field of electrical invention and adaptation, which was once thought to be extremely limited as to possibilities, is now recognized as being practically boundless. In 1904 Mr. Condit organized the Condit Electrical Manufacturing Company, of which he is now President and Treasurer. This Company has developed a special line of electrical protective devices, such as oil switches, air circuit breakers, relays, etc., which have been adopted by some of the most prominent Lighting and Power Companies in the country. Under the progressive management of Mr. Condit the business has shown a continuous and steady growth.

HARRY A. CURRIE

Harry A. Currie, assistant electrical engineer of the New York Central lines, was born in Nova Scotia in 1872, and was educated in Halifax and New York City. His father was a Presbyterian minister and professor in the Theological

HARRY A. CURRIE

Seminary at Halifax up to the time of his death and had a high reputation in Europe and America as a Hebrew and Arabic scholar. When seventeen years of age Mr. Currie went to sea for over three years, and during his voyages visited South America, China, Australia and France. The experience gained by these trips was of vast benefit to him in after life. Coming to New York City, he took a special course in electrical engineering at the Cooper Union, and in 1894 entered the employ of the Brooklyn Rapid Transit Company. In this connection he assisted in the electrification of the company's elevated lines and made tests of equipment for the Interborough Rapid Transit Company when that corporation first projected electricity for its motive power. In 1904, he was appointed to his present position with the New York Central and had charge of all the work at Schenectady in connection with the building of experimental tracks and the testing of electric locomotives and cars. He also had charge of the electric transmission work for the company in the electric zone of New York. Mr. Currie served on the Commander Jessup Committee in connection with the inspection and electrical welding repairs to the interned German ships in the Port of New York. He is a member of the Engineers Club, New York Electrical Society, American Institute of Electrical Engineers, Canadian Society and Canadian Club. His offices are in the Grand Central Terminal and he resides on North 29th Street, Flushing, L. I.

PROF. CHARLES R. CROSS

Charles Robert Cross, a descendant of Robert Cross, immigrant from England to Ipswich, Mass., 1637, was born at Troy, N. Y., March 29, 1848, and graduated from the Massachusetts Institute of Technology, 1870. He was immediately thereupon appointed Instructor in Physics, made full Professor in 1875 and Thayer Professor of Physics, in charge of the Department, in 1878. In 1885 he was given the additional title, Director of the Rogers Laboratory of Physics. He retired from active teaching, and was made Professor Emeritus at the close of 47 years of service in 1917. During the above years his name and influence became known to thousands of students in that great center of professional learning.

Professor Cross was greatly interested in the practical application of electricity to telephony, electric lighting, and power transmission, which began to assume definite shape in the earlier years of his teaching. He desired that the Institute should establish a Course in Applied Electricity or Electrical Engineering as early as 1880 and in 1881 gave an optional course of lectures devoted to these subjects which excited so much interest that a year later he proposed to the Corporation of the Institute the establishment of such a course leading to a separate degree. This proposition was accepted and public announcement made of it in August, 1882. In September of the same year this course was

FARLEY G. CLARK

opened to students, a class of six entering. This first class was graduated in 1885. Professor Cross continued in charge of this course for twenty years. Almost immediately after its establishment it became one of the leading courses at the Institute, and before long it and the Mechanical Engineering Course became the two largest.

Professor Cross was a member of the National Conference of Electricians and a member of the Board of Judges at the Franklin Institute Electrical Exhibition in 1884. He was Chairman of Section B of the World's Electrical Congress at the Chicago Columbian Exhibition, 1893. Also he was one of the six Vice-Presidents of the American Institute of Electrical Engineers chosen at its organization in 1884.

He has published various papers upon physical subjects, mostly in the Proceedings of the American Academy of Arts and Sciences, and has given many public courses of lectures, among others a number before the Lowell Institute at Boston.

He has been largely concerned with the furtherance of scientific research in this country. For many years he has occupied the position of Chairman of the Rumford Committee of the American Academy of Arts and Sciences, which is charged with the appropriation of the income of the Rumford Fund of $66,000 in aid of researches in light and heat and for the award of the Rumford Medal to distinguished investigators in those subjects. He is also a Trustee of the Elizabeth Thompson Science Fund and Chairman of a Committee of the American Association for the Advancement of Science, having to do with the collection of statistics regarding scientific research funds of this couwntry.

Professor Cross has acted as an expert in much of the patent litigation in the United States Courts regarding electrical inventions. He acted thus for the American Bell Telephone Company in all the "Telephone Suits" relative to the patents of Professor Bell and also in various other suits relating to telephony. He also took part in many suits relating to dynamo electric machinery, electric lamps, both arc and incandescent, the transmission and distribution of energy and storage batteries. He likewise acted for the Marconi Company in the fundamental suits relative to the invention of radio telegraphy.

FARLEY G. CLARK

Farley G. Clark, who is now chief engineer of the Toronto Railway Company and its numerous subsidiaries, thus filling one of the most important executive positions in the list of Canada's electrical interests, has won his way by gradual but consistent progress from a beginning as general electrical worker to his present important responsible position.

He was born in Palmer, Massachusetts, July 21, 1871. By maternal descent he traces his ancestry back to a Mayflower passenger, and his ancestors were English, Scotch and Irish. His elementary and preparatory education was received in the public schools and in Wilbraham Academy, and his college work was done in the Massachusetts Institute of Technology and in Cornell University, from which he was graduated in 1894. His college fraternity is Sigma Alpha Epsilon.

He had always been interested in the problems and phenomena of electricity, and following his graduation he took it up in an effective and practical way by engaging in August, 1894, as a general worker in the employ of E. C. Hughes & Company, doing a general electrical contracting business at Providence, Rhode Island. The position proved valuable from an educational standpoint, for his next position was as an inspector with the Electrical Maintenance Company, in New York City. From there he went into the employ of the Crocker-Wheeler Company as salesman for the extensive line of electrical machinery of which that company is manufacturer.

He began electric railway service after that, beginning with the Metropolitan Street Railway Company of New York, with which company he held various positions up to electrical superintendent. He left that connection to engage as electrical engineer with the noted engineering firm of Westinghouse, Church, Kerr & Co., and after that was superintendent of power of the Pennsylvania Tunnel and Terminal Company in New York City, operating the Tunnel Terminals of the Pennsylvania Railroad System. After that be became superintendent of power with the Westinghouse Electric and

Manufacturing Company at its great works at East Pittsburgh, Pennsylvania.

He remained in that position until appointed to his present one of Chief Engineer of the Toronto Railway Company and its subsidiaries. This is a large and very important electric street railway enterprise, owning the entire railway system of Toronto and also owning as subsidiaries corporations engaged in electric railway, light, power, and electrical transmission activities. The subsidiaries are the Toronto Power Company, Toronto and Niagara Power Company, Electrical Development Company, Toronto Electric Light Company, London (Ont.) Electric Company, and the Niagara Falls Gas and Electrical Transmission Company. This represents a very large combination of electrical activities under a single control, and Mr. Clark is giving to the extensive electrical operations of these enterprises the benefit of long experience and of trained technical, practical and executive skill. He has been continuously occupied with electrical and engineering operations since leaving college except for a period of military service in the Spanish-American War and part of the Philippine Insurrection, with the United States Engineers.

Mr. Clark is deeply interested in the problems and progress of electrical science and mechanical engineering in general. Outside of his direct professional occupation as an electrical engineer he gives much thought and experiment to the theory and design of aeroplanes, the theory and design of internal combustion engines and to electrochemical research and experiment. He keeps in close touch with the progress and development of electrical science and is an expert in all that pertains to electrical railway operation and management and to the many problems connected with the generation and transmission of electric light and power.

He is a fellow of the American Institute of Electrical Engineers, a member of the American Society of Mechanical Engineers, the Canadian Society of Civil Engineers, the Institution of Electrical Engineers, London; the National Electric Light Association, American Electric Railway Association, the Engineers' Club of New York, Engineers' Club of Toronto, the American Association for the Advancement of Science, and a fellow of the American Geographical Society, membership in these technical and general scientific societies representing the interest taken by Mr. Clark in cognate subjects, and the progress and development of scientific knowledge in general, as well as the special appeal made to him by the problems and advancing developments in his own profession. His own work and methods have done much to improve electrical engineering practice in the departments of electrical service to which they have been devoted.

The social organizations in which he has membership include the Niagara Club of Niagara Falls, N. Y.; the Lambton Golf Club of Toronto, and the Engineers' Country Club of Roslyn, N. Y. He is also a member of the Masonic Order, a Knight Templar and member of the Order of Nobles of the Mystic Shrine.

HARRY H. CUTLER

HARRY H. CUTLER

Harry H. Cutler, one of the leading electrical experts of New England, who is an inventor of many appliances connected with the industry, was born in Brookline, Mass., in 1859, the descendant, in a straight line, of an ancestry that located in Massachusetts in 1630, all of whom have since lived in Boston or within a radius of fifty miles of that city. He was educated at the Massachusetts Institute of Technology, and graduated in 1881, with the S.B. degree, and this training was supplemented by a special post-graduate course of one year. He was induced to adopt electricity as a profession largely from knowledge gained in writing his graduating thesis in 1881, and conducting a series of tests on the subject "Losses in Transmitting Power by Means of Belts and Shafting." In his thesis Mr. Cutler stated that this method was a disgrace to the mechanical profession and that the ideal way would be to transmit electrical power over insulated wires direct to electric motors attached to the various machines to be driven, provided an electric motor could be developed to do this work. By the time he had acquired sufficient experience, he took up his life work designing and building electric controllers adapted for special appliances of electric motor drive. After leaving college Mr. Cutler was in 1883 a member of the firm of Cutler & Mower, mechanical engineers, at Boston, Mass., and in 1884-5 he took the student's course at the Thomson-Houston Electric Company's plant, Lynn, Mass. His special preparation for his future work also included one year as assistant instructor in the steam engine laboratory of the Massachusetts Institute of Technology, six months as salesman for the Crosby Steam Engine Indicator and in instructing purchasers how to use it and set the valves, etc., on steam engines, and one year with the Southwark Foundry & Machine Co., builders of the Porter-Allen high-speed engine. With this practical preparation along all lines he began his active business career in May, 1885, as superintendent and general manager of the Citizens Electric Light & Power Company, Akron, Ohio. His subsequent connections were: superintendent and general manager of the Newton Electric Light & Power Co., Newton, Mass., in 1887-89; superintendent electrical department Newton & Watertown Gas Light Company, Newton, Mass., in 1890; manufacturer of electric street lighting fixtures in Newton, Mass., 1890-91; general manager Electrical Expert Company, Chicago, Ill., 1891-92. He organized the firm of Cutler & Hammer, Chicago, Ill., February 22, 1893, and in September of the same year F. S. Terry joined the organization and the Cutler-Hammer Manufacturing Co. was incorporated. This company manufactured electric controlling devices and Mr. Cutler became its treasurer and chief engineer, September 1, 1893, advancing to the position of president and continuing as treasurer and chief engineer from 1896 until 1898. The company afterwards removed to Milwaukee, Wis., Mr. Cutler becoming general manager and chief engineer in 1899, and from 1903 until 1907 was vice-president and chief engineer of the company. He continued as vice-president until 1916 and the year following sold his interests and retired entirely from the organization. Mr. Cutler's first notable achievement was in designing and reconstructing the arc lighting circuits in Akron, Ohio, in the summer of 1885, so as to stop all inductive effects on the grounded telephone lines used at that time. This successful installation caused the withdrawal of a suit for $40,000 damages brought by the Central Union Telephone Company and it constituted the first electric lighting plant arranged to stop all induction troubles on the telephone lines. His second work of large importance was designing and installing at Newton, Mass., in 1887, the high

tension alternating current system of incandescent street lighting, using several circuits of forty 25 volt lamps connected in series, directly across the 1000 volt primaries and carrying transformers on the same lines stepping down to 50 volts. This successful system was used for lighting stores and other business places six miles from the central station. The generator used was the first one sold by the Thomson-Houston Company and it was exhibited at the National Electric Light Association Convention held at the Parker House, Boston, Mass., in 1887. While located in Akron, Ohio, Mr. Cutler installed and operated the city's first incandescent lighting system. The first man he tried to induce to use the service said: "Do you mean to tell me that you can light my place with those red hot hairpins? It's nonsense, get out of here." Within ten days, however, he had contracted for the 1000 lamp capacity of the dynamo, which generated 150 volts with circuits arranged for two 75 volt lamps in series. During his work in Newton, Mass., Mr. Cutler was employed on many occasions as an expert witness for the Thomson-Houston Electric Company and its customers, who were invariably opposed by the New England Telephone & Telegraph Company, whenever said customers asked for an electric lighting franchise. The objections of the telephone company were based on the ground that an electric lighting system would cause serious induction troubles in the telephones. In every one of these cases Mr. Cutler was able to show that there would be no induction troubles from electric lighting circuits, if the systems he had devised and constructed in Akron, Ohio, and Newton, Mass., and other installations, which he had laid out, were adopted. Mr. Cutler's clear and concise explanation was instrumental in winning every case in spite of the testimony of Prof. Charles Cross of the Massachusetts Institute of Technology, Thomas B. Lockwood and other notable telephone experts. The telephone people at that time claimed the exclusive use of the earth as a return circuit for telephone lines, because they were the first in the field. The trolley car and lighting circuits doubtlessly compelled the telephone companies to build complete metallic circuits to the great benefit of the service, long before they would otherwise have adopted this method. Mr. Cutler's investigation and research work has been thorough and continuous. He has been a most indefatigable worker in the development of the science and has evolved many valuable appliances for various uses where the mysterious current is used. In all he has taken out seventy-six patents and is still engaged in the inventive field, his time now being spent in experimenting with mechanical inventions, and as a diversion from his arduous work he has taken up automobiling and golf playing, two pastimes in which he finds complete relaxation from the manual and brain fatigue resulting from the intricate problems in which he is enthusiastically interested. Mr. Cutler is a member of the American Institute of Electrical Engineers, the Boston City Club, several golf clubs and other social and scientific organizations. He makes his home at Brookline, Mass., and spends a part of each winter in the South.

CHARLES E. CAMPBELL

Charles E. Campbell, of Lynn, Mass., President of the Campbell Electric Company, is an engineer whose inventive genius has been exercised most successfully in the electrical field. From his boyhood it has been his ambition to draw from their hiding places electrical truths. How well he has succeeded in his chosen calling is nicely told by the records of the U. S. Patent Office and by the modern and magnificent plant erected to supply the ever increasing demand for Campbell products. His early practical work was on telephones, selective signal systems and special lighting appliances. Among the lighting devices invented and patented by Mr. Campbell are the self-winding time switch and several high tension time switches and the induction lamp. The demand that followed the introduction of his inventions warranted

his establishing business as a manufacturer in Lynn, Mass., in 1901.

The more complicated field of radiography and fluoroscopy, however, which at that time was in its infancy, supplied him an opportunity to reveal to his fellow men and the world his superior inventive genius. He invented and patented the first portable X-Ray coil based on the Tesla current, and to-day there are thousands of them in use by the leading members of the medical profession. Then followed the invention of the Surex transformer, which embodied electrical principles in construction that enabled the roentgenologist to depart from the elements of guess and approximation that surrounded him in producing a radiograph. In a word, the Surex transformer revolutionized the construction of X-Ray transformers. Following the same electrical principles embodied in the Surex transformer, he set to work to again simplify the apparatus, with the result that the Campbell Electric Company has now made available an automatic Surex transformer so simple in its operation that the novice in X-ray can operate it. Second only to the automatic transformer is his invention of the Campbell motor-driven Tube Tilt X-Ray Table, which has revolutionized technique in both radiography and fluoroscopy, making it possible to examine and radiograph all parts of the human body in all positions without moving the patient from the table. The results accomplished by Mr. Campbell in producing this table were regarded as impossible of accomplishment by leading manufacturers of X-Ray apparatus of the country without the construction of a large unwieldy and impractical apparatus. The Campbell Tube Tilt Table is no larger than the ordinary X-Ray table, and requires only the pressing of a button to place it and the patient in any desired position.

Mr. Campbell received the highest award from the Panama-Pacific International Exposition, held in San Francisco in 1915, for his X-Ray and high frequency apparatus, and was the only manufacturer to receive an award at the International Red Cross Conference, held at Washington, D. C., May 7-17, 1912.

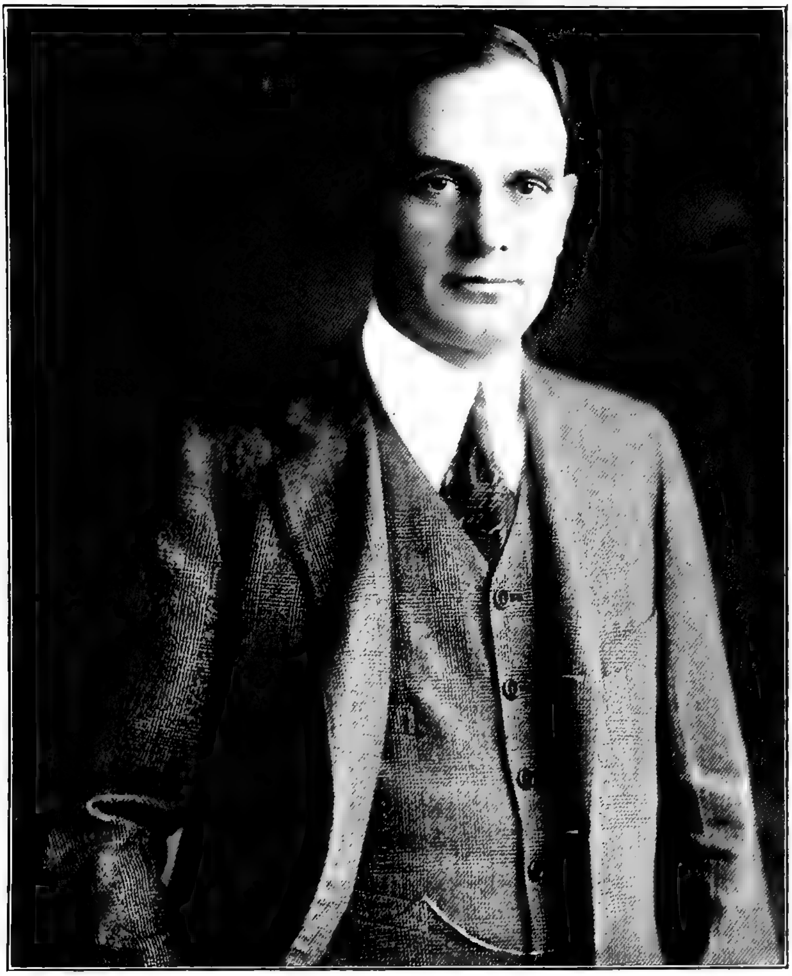
L. H. CONKLIN

When the vast industries and innumerable applications of electricity to the uses of the common life are considered, and how in reference to light, heat, power and other necessary concomitants of civilized existence we depend so greatly on the versatile utility of electric currents, it seems truly wonderful that most of these electric manifestations have been evolved, so far as their common uses are concerned, in the past three or four decades. In the profession of electrical engineering men still young or in early middle age, who have been in practice twenty or twenty-five years, rank as "old-timers" at ages when in other professions they would be ranked as junior practitioners.

It is these "old-timers" who are to be credited with most of the creative work and among whom may be found most of the notable examples of success in things electrical. Strong in the fundamentals, their technical and practical knowledge is strongly reasoned and soundly based.

One of these men whose career has been constructive and successful is L. H. Conklin, whose work, both technical and administrative, has earned him prominence in the electrical profession.

Mr. Conklin was born in Brooklyn, New York, December 7, 1872, descendant, in the maternal line, of a Connecticut pioneer settled in 1630, and on the father's side of an old Long Island family. He was graduated from Pratt Institute, in Brooklyn, in 1891, and, beyond the manual training course there, had no school preparation for his profession. He had from boyhood looked forward to an electrical career, but he is one of the few "old-timers" who never worked for the larger companies, such as the General Electric Company or Westinghouse Electric and Manufacturing Company. His first connection with the electrical business was in the factory of Eickenmeyer & Osterheld, Yonkers, New York. After a short time there he went to the Excelsior Electric Company, Brooklyn, as assistant to Mr. William Hochhausen, its manager, a wonderful electrical engineer and an inventor of profound insight and commanding genius. Working with that skillful pioneer



L. H. CONKLIN

inventor in his private office every business day for two years, Mr. Conklin obtained the most valuable training. He became Mr. Hochhausen's chief assistant in design and experimentation, and at the age of twenty-four years was made superintendent of the electric department of the Flatbush Gas Company, Brooklyn.

He became a member of the firm of Weiderman & Conklin, contractors and engineers, and was engineer for plants controlled by A. M. Young in New England. Later he accepted the position of General Superintendent of the West Penn Railways Co., operating in the Pittsburgh district, and from there went to Scranton, Pennsylvania, to become manager of the Scranton Electric Company, owned by the American Gas and Electric Company; supervising operating for J. G. White & Company, and he is at present Secretary, Treasurer and General Manager of the United Service Company. He has had especially notable success in the work of combining small plants in a successful holding company.

Mr. Conklin is a fellow of the American Institute of Electrical Engineers; member of the National Electric Light Association and for the past six years a member of its Rate Research Committee; was organizer and first President of the Pennsylvania Electric Association; member of the American Electric Railway Association, and of its Committee on the Training of Employees.

He is a member of the Railroad Club, New York, the Scranton Club and several smaller golf clubs, and has a great liking for outdoor recreation and boy scout work.

HENRY HAVELOCK CUMMINGS

Henry H. Cummings, of Boston, Mass., who is an inventor of many contrivances used for the navigation of steamships, is now engaged in perfecting an electric log and several special electric instruments that will be of great help to mariners. Mr. Cummings was born February 28, 1858, in Worcester, Mass., the son of Elkanah Andrews and Emily Cleveland (Spicer) Cummings. The father was a Baptist minister, who afterwards took up teaching and the development of real estate. Mr. Cummings was educated at the Maplewood Grammar School, Malden, graduating in 1871. As a child he displayed remarkable mechanical tact, and in his early boyhood invented and constructed a household device that saved his mother much labor. Previous to and during the time he was at school he aided his father in the manufacture of heels for the Boston and Lynn shoe manufacturers. After the completion of his education he started a small printing establishment in connection with one of his brothers. He was then employed in a dry goods store in Boston, but left this posi-

tion in 1875 to learn the trade of machinist. He was twenty-three years old in 1881 when he started the Cummings Machine Works, one year later taking A. D. Crombie as a partner. This connection continued for twenty-two years, and was dissolved by the retirement of Mr. Crombie, whose interest Mr. Cummings purchased. The business was incorporated in 1905, Mr. Cummings becoming president and treasurer. Before he established his own business, he began his career as an inventor, and since that time has been granted one hundred and thirty patents. The most important among these is a button-sewing machine, a device for seed packing, an improved printing press, a sub-target gun and an engine-log system by which the speed of a steamship is automatically indicated. It also records the distance traveled, the direction of rotation of each propeller, the total average number of revolutions and the average number per minute. These are all indicated simultaneously, with extreme accuracy, and the system aroused the keen interest of marine people in this country and abroad. It is now the standard equipment for ships of the United States Navy. He also invented many other machines and devices to be used on steamships in connection with the engines and other parts of the ship's apparatus. One of the most interesting inventions is The Cummings "Dot Rifle," a simple and scientifically accurate device by which a person can, without using ammunition, engage in target practice with an ordinary rifle. The system can also be used in machine guns, pistols and on the large naval guns. By this system a marksman can attain, in a few weeks, a higher grade of skill than he could by devoting the same number of months on a regular range with service ammunition.

Mr. Cummings is a Republican, and during 1894 he was elected a member of the City Council of Malden by that party, serving during 1894-95. He is a member of the Massachusetts Republican Club, and the other organizations with which he is, or has been connected, are the Highland Glee Club, Boston Yacht Club, Boston Chamber of Commerce, Bostonian Society, American Society of Naval Engineers, American Society of Mechanical Engineers, Navy League, Reciprocity Club of America, United Order of the Golden Cross, Workmen's Benefit Association, Aero Club of New England, and the Malden City Government Association. He has resided in Newton since 1904, and is an attendant at the Congregational Church, Newton Highlands. He served as a deacon from 1912 to 1915, and is a member of the Congregational Club. He is the owner of motor boats and takes great pleasure in short ocean trips.

On February 24, 1886, he married Jane Clark Crombie, daughter of his former partner, Albert D. Crombie, of Malden, the union bringing two children, Sylvia, who died at the age of five years, and Esther Cummings.

Mr. Cummings believes a boy should decide what work he was best fitted for as early as possible, and then bend every energy to attain success in that line and philosophically supplements this advice by the statement that "it is much better to be a good mechanic than a poor doctor."

During his entire life Mr. Cummings has been one of the most industrious and persistent workers, which accounts for his success both in the line of manufacture and that of invention. He has, however, found time to devote to religious, educational and social matters, and his relaxation from the strain of business comes from these and yachting.

He is now working on an electric log and special electric navigating instruments.

Mr. Cummings, by reason of his work for the Navy Department, has authority from Secretary Daniels to board any steamship in the service, in order to test his instruments. He is passionately fond of the sea and makes frequent trips upon the boats going out for target practice. He has also made short trips in American submarines.

The Cummings machine works, which are located at 110 High Street, Boston, give employment to 160 hands, 60 of whom are women.

H. C. CUSHING, JR.

H. C. Cushing, Jr., who, in addition to his achievement in electrical work, has contributed much literature to the advancement of the science, was born in Maryland, May 14, 1869. He began practical work in the testing department of the Mather Electrical Company, Manchester, Connecticut, in the fall of 1888, under Professor William A. Anthony and after one year in this connection entered Cornell University for a two-years' special course in Electrical Engineering. Upon graduation he was employed by the Thomson-Houston Electric Company and the General Electric Company from 1891 until 1893, when he was appointed Chief Electrical Inspector of the Boston Board of Fire Underwriters, a position he retained until his selection as Chief Electrical Inspector of the Fire Underwriters'

Tariff Association of New York City in 1895. Five years later he became business manager of the Electrical World and in 1901 resigned this position to establish and publish the Central Station, which at this time is entering its seventeenth year of publication. In 1894 Mr. Cushing brought out the first edition of his handbook, "Standard Wiring," for electric light and power. This book is revised annually, and since its first issue, twenty-five years ago, it has been the acknowledged authority on electric light and power wiring and installation. Mr. Cushing is a direct descendant of John Cushing, who came to America in 1638 and founded the town of Hingham, Massachusetts, which he named after his birthplace in England.

He is a Fellow of the American Institute of Electrical Engineers and member of the National Electric Light Association, the Cornell University Club, the Country Club of West Chester, the Huguenot Yacht Club and the Kappa Alpha Fraternity. His business address is 8 West 40th Street, New York City.

WILLIAM DAVID COOLIDGE

WILLIAM DAVID COOLIDGE

Dr. William D. Coolidge, assistant director of the Research Laboratory of the General Electric Company, was born in Hudson, Mass., October 23. He was graduated from the Massachusetts Institute of Technology, B. S., 1896, and from the University of Leipzig, as Ph.D., in 1899.

He has since been identified with the important research work conducted in the laboratory of the General Electric Company under the general direction of Dr. Whitney. He has made many important investigations and inventions, the most important being the invention of ductile tungsten and its various applications, and for this invention was awarded the Rumford Medal in 1914. Another important invention of his is a Roentgen Ray Tube with a Pure Electron Discharge, and there are several others to his credit that rank among the most valuable contributions to electrical science.

He is a member of the American Chemical Society, American Electrochemical Society, American Physical Society, American Academy of Arts and Sciences, Washington Academy of Sciences, American Institute of Electrical Engineers, American Roentgen Ray Society, Roentgen Society of England, and the Chemists' Club of New York.

W. G. CHACE

The profession of electrical engineer has attracted to its ranks many of the brightest minds. It is only two or three decades since the profession, as applied to light, heat and power, had its inception. Its possibilities for creative work, adding the joys of scientific achievement to the rewards of success led many who had begun other vocations to seek the training prerequisite to success in electrical paths. Thus it was that Mr. W. G. Chace, a native of Lincoln County, Ontario, who, after taking public and high school courses at St. Catherine's in that county, had himself taught in public schools for six years, entered the University of Toronto and, specializing in courses in electricity and hydraulics, was graduated with honors in the degree of Bachelor of Applied Science.

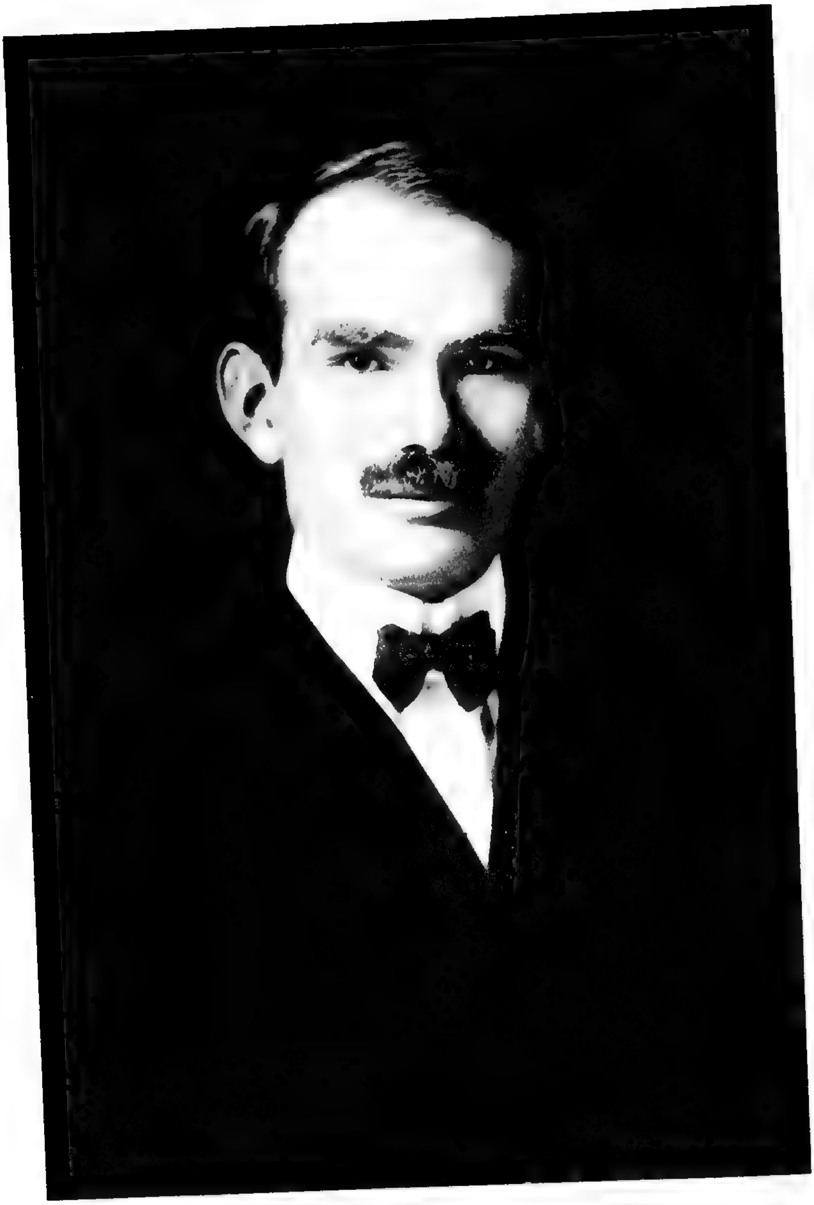
During the period of his university studies he served a summer apprenticeship in electrical work, and after graduation began

as field draughtsman, then became engineer in hydro-electric work, later adding to experience in electrical, hydraulic, and construction works. He was resident engineer on extensions of the hydro-electric plant of The International Railway Company, 1903-1905. Since 1905 he has held a series of responsible relationships as assistant to chief or chief engineer, and in administrative positions chiefly in connection with developments and constructions. He was electrical engineer of the Temiskaming & Northern Ontario Railway Commission, 1905-1906, and hydraulic engineer for the Hydro-Electric Power Commission of Ontario, 1906-1907. He was a member of the firm of Smith, Kerry & Chace, Toronto, 1907-1912, and of Kerry & Chace, Limited, Toronto, 1913-1916, in general practice as consulting and supervising engineers. He was chief engineer of the City of Winnipeg Power Development, 1908-1911, and since 1913 has been chief engineer of the Greater Winnipeg Water District.

Mr. Chace holds a representative place in the profession, especially in the development of hydroelectric systems. He is chairman of the Winnipeg Technical Committee, associated with the Honorary Council for Scientific and Industrial Research of the Dominion of Canada. He is a member of the Engineering Institute of Canada, and was chairman of its Manitoba Branch, 1915-1916. He is a member of the Institution of Electrical Engineers of Great Britain, and Fellow of the American Institute of Electrical Engineers. He is president (1917-18) of the Elmhurst Golf Links, Ltd., Winnipeg.

DR. LEE DE FOREST

Dr. Lee de Forest, one of the pioneers in wireless telegraphy, whose genius created the De Forest Audion Amplifier, an instrument that made possible transcontinental telephony and transoceanic radio telephony, has during his entire lifetime been one of the most indefatigable and successful workers in this branch of electrical science. He has, in all, taken out over one hundred patents here and abroad on radio telegraphy and telephony, each one of which has materially aided in the world development of the wireless, but his crowning achievement is the Audion Amplifier, which has accomplished what the scientists of the world have vainly endeavored to do for a score of years. Dr. de Forest is a native of Council Bluffs, Iowa, where he was born August 26, 1873, and was educated at the Mt. Hermon (Mass.) Boys' High School. He then entered the Sheffield Scientific School of Yale University for the electrical and mechanical engineering course, graduating in 1896. In 1899 he received from Yale University the degree of Ph.D. for work in physics and mathematics. For a time after leaving college he was attached to the Western Electric Company's Telephone Department in research work, when he began business for himself. From early youth he had determined to devote his energies to electricity and inventions, and he followed this inclination consistently by carefully educating himself for research along the lines selected for his life work. His first important work was the development of the Radio Teleraph System, which bore his name from 1902 until 1910. In 1906 he began work on the Radio Telephone. For over a score of years telephone engineers had sought in vain a repeater or amplifying relay which should be at once extremely sensitive, free from delicate and frequent adjustments, and yet which would amplify every modulation or variation of the human voice without distortion. Without such a relay the telephone, at that time, was limited to a few hundred miles. The problem was a baffling one to the inventors and engineers in the telephone industry, and to stimulate action along this line of research an Eastern telephone company, in the late nineties, offered "one million dollars" for a successful telephone relay. This prize was never claimed or awarded. The engineers still continued to work along the same lines, numberless patents were issued and untold thousands of dollars were spent on the problem. Meanwhile, through all those years, the long-distance telephone halted, stopped effectively by



LEE DE FOREST

that trifling little barrier—the repeater relay. Prof. Pupin, of Columbia University, had discovered and patented the inductance coils which alone made it possible to speak intelligibly on overhead lines one thousand miles or over cables twenty miles in length. He sold his patents to the Bell Telephone Company many years ago, but the transcontinental telephone still remained a commercial impossibility. Theoretically it was possible to build a line with very large copper conductors and plentifully spaced with Pupin coils, which would enable one, by using large electrical currents in the transmitter, to telephone across the continent. But, commercially, the staggering cost of such a line put this method absolutely out of consideration—it was impossible. So the telephone world waited hopefully for that yet unfound—the relay which could alone enable one to send, clear and audible, the infinitely delicate variations of the voice across North America. At last that result was attained—not by telephone engineers, whose minds had for years spun in the old rut of receiver-michrophone "Siamesed" together, but by de Forest, who, beginning his pioneer experiments with wireless detectors, 'way back in 1902, discovered that a heated gas was "sensitive" to the weak "wireless" waves and could constitute a new detective for use in radio telegraphy. In 1903-4 Dr. de Forest made on this principle a genuine practical detector, possessing a sensitiveness far in excess of any hitherto known wireless receiver. Indefatigable in his efforts to further improve and apply his "Audion," this little incandescent lamp (which made *audible* the action of the *"ions,"* or sub-atoms, of the heated gas around the filament), Dr. de Forest discovered that these "ions" responded to telephonic currents as well as to those of the far higher frequencies used in wireless. He found that when this strange device, so utterly new to the telephone field, was properly connected in the line between a transmitter and a receiver, the Audion actually amplified the voice currents, giving a reproduction of perfect fidelity without a trace or lag or distortion, yet with an increase in volume, or intensity. He patented the Audion Amplifier in 1907, but it was not until 1912 that he had brought it to such a state of perfection that he felt justified in bringing it to the attention of the engineering staff of the American Telephone and Telegraph Company. Three times this company has purchased patent rights under the Audion and other patents, paying nearly a half million dollars for them. The Audion Amplifier proved to be the long-sought telephone repeater, or relay, of almost infinite sensitiveness and power, free of adjustment and distortion. Its use made possible, in 1915, the opening of the first transcontinental telephone service. Since then its introduction in long-distance telephone service in this country and abroad has been almost universal.

By use of large oscillating Audions, wireless telephony from Washington to Honolulu has been achieved, and the detector is now used exclusively for long-distance signalling the world over—especially in the U. S. Navy Service. A work devoted to the progress of electrical science would be as incomplete without a description of Dr. de Forest's wonderful invention as it would be were the discoveries of Professors Morse and Bell left out; hence a few words about the Audion Amplifier. This instrument consists of a small incandescent lamp bulb exhausted of air, containing, in addition to the usual filament, two thin plates of nickel about one-eighth of an inch from the filament on either side. Between the filament and the plates are two pieces of nickel wire bent grid-shaped. That is all. Can you imagine anything more simple, more utterly unlikely to operate as a repeater of telephone currents? Yet this little lamp was the one thing missing in the successful system of transcontinental and transoceanic communication. It links the Eastern with the Central, the Central with the Mountain, and that with the Pacific Coast. In the Amplifier, the incoming current, to be repeated and amplified, is conducted to the "grid" wire. The outgoing line is connected, one terminal to the plates, the other to the filament. In this circuit is found a battery. A separate battery lights the filament to incandescence. The heated gas becomes then a conductor of the local current from the battery, which can pass from the cold plates to the hot filament. In

other words, negatively charged "carriers," "ions," or "thermions," as they may be termed, speed in invisible streams of almost infinite tenuity from filament to plates, passing in their migration through the spaces between the wires of the "grids." Now, the slightest electrical potential, or charge, of electricity impressed upon these "grids" from the incoming telephonic currents deflects or retards some of these tiny carriers of negative electricity. This effect is always proportional to the cause, so that the current changes produced in the outgoing, or "plate," circuit are similar to those current changes, or electrical charges, upon the "grid" wires which produced them. But the changes in current thus produced are many times in volume or intensity the changes in current which caused them. In other words, a unit electrical charge delivered upon the "grid" produces a deflection, or stoppage, of six to ten unit electrical charges passing from the filament to the plates. Hence the strange amplifying properties of the Audion. The one most essential and completely novel element in the whole strange device is the "grid" member, interposed across the path of the traveling ions ("wanderers," as their Greek name implies). Dr. de Forest chose to deal then with "ions," gas atoms or sub-atoms—matter in its most tenuous form, what Prof. Crookes well styled the "fourth state of matter." Try to imagine one of these ionic carriers of the voice, or electric charges, and contrast it with a carbon granule of a michrophone transmitter of the early "telephone relays." Compare a soap bubble with a load of coal, and you will have some relative idea of the difference between the delicacy and elegance of the Audion and that of the old microphone relay. Transoceanic telephony by submarine cable, with numerous Pupin coils and the Audion Amplifier, is theoretically possible; commercially, an utter impossibility. The cost of such a cable would be prohibitive. But transoceanic wireless telephony is within reach. The de Forest Audion and Amplifier, extending, as they have, the range of wireless and making loud those signals which otherwise are inaudible, makes this result possible. Dr. de Forest's work in wireless telegraphy was recognized by the St. Louis Exposition Jury of Awards in 1904 by the bestowal of a gold medal for his research work and discoveries along that line. He was also awarded a gold medal by the Panama Pacific International Exposition held at San Francisco in 1915 for the part his Audion Amplifier played in the transcontinental telephone service opening that year, as well as for the Oscillion and Audion Detector, which made possible the transoceanic radio telephone communication from Allington to Honolulu and Paris in November, 1915. He is a member of the Yale Club, the American Institute of Electrical Engineers, the Institute of Radio Engineers, Franklin Institute, of Philadelphia, and the Wireless Association of America. He is president of the Radio Telephone and Telegraph Company and the de Forest Radio Telephone and Telegraph Company. He resides at 232nd Street and the Hudson River, and his laboratory is located at 1391 Sedgwick Avenue, in the factory of his company.

HENRY L. DOHERTY

THE DOHERTY ORGANIZATION

Doherty means much in the world of electricity. It designates Henry L. Doherty, head of the public utility operating firm of Henry L. Doherty & Company; and it also signifies the trade name of the Doherty Organization, comprising 16,000 members, and engaged in every phase of electrical, manufactured gas, traction, natural gas and oil operation. Mr. Doherty is proud of his rise from the position of office boy in the Columbus Gas Company, in 1882, to that he now occupies, but his pride in the Doherty Organization is even greater. It is the members of this Organization who must, eventually, carry on the principles known in the utility world as "Doherty practice and service."

The Doherty Organization, in its embryonic state, dates back thirty-five years, as its inception in Mr. Doherty's mind anticipated the actual founding by two decades, but its growth has far exceeded the most roseate dreams of its founder and commander.

Mr. Doherty had long been one of the foremost utility operators when he started what has become one of the most noted as well as valuable features of the Organization. This innovation was first generally termed the "cadet school" and its results were known as the "Doherty Schools of Practice" and now as the "Doherty Schools of Training." The first school was run in connection with the Denver Gas & Electric Light Company, the students being graduates of the engineering schools of leading colleges and universities. In the "cadet school" they practiced what they had studied and, in addition, secured the priceless privilege of being able to demonstrate their theoretical knowledge under the tutelage of experienced men. The "cadets" serve a two-year course and are then graduated into the active ranks. As evidence of the success of this project it may be stated that many of the leading executives of the Organization are former "cadets." As the Organization grew the number of schools was increased and broadened in scope. Today four schools train men for all the phases of the oil industry as well as for electric, gas and traction practice.

When Henry L. Doherty & Company opened their New York offices the force consisted of a half dozen; today it is 300. In those days the number of companies operated was four; today sees some 150 controlled and directed by the Doherty Organization, located in twenty-eight states of the Union, the Dominion of Canada and even in Mexico. Tank cars bearing the Doherty emblem cross the continent, and ships flying the Doherty flag sail the seven seas. These are but a few of the developments of fourteen years, but serve to indicate, briefly, the scope of the Doherty Organization.

HENRY L. DOHERTY

Keen business judgment, wide experience and unusual power of organization have made Henry L. Doherty a dominant figure in financial and commercial affairs. He is one of the most picturesque personalities in the public utility field, and his wonderful rise to a commanding position in a few years equals the achievement of any of those who have risen to eminence along similar lines. While persistent and energetic, Mr. Doherty is reticent and retiring, which is the possible reason his name is not as well known as those of men who have courted publicity. Mr. Doherty, now head of the banking house of Henry L. Doherty & Company, is an engineer by profession and early in his career devoted his entire time to practical utility work. He was born in Columbus, Ohio, May 15, 1870, son of Frank and Anna (McElwain) Doherty. His father was an engineer and inventor and was descended from William Doherty, who came to the United States about 1800 and served as the first adjutant general of the State of Ohio. Mr. Doherty's great-grandfather was State Librarian of Ohio and also served with distinction under Commodore Perry, on Lake Erie, being brevetted for bravery on that occasion. The maternal side of the family is of English, Scotch and Irish ancestry. Mr. Doherty attended the public schools until he was twelve years of age and finished his education by self-study. He entered the employ of the Columbus Gas Company in 1883 and, after serving in various capacities, rose to the dual position of chief engineer and assistant to the manager. Later he transferred his energies to the Madison Gas and Electric Light Company, Madison, Wis., as manager and rose to the presidency of that company in a short time. He afterwards filled, either successively or simultaneously, the positions of engineer of the Columbus Electric Company; general manager of the St. Paul (Minn.) Gas Light Company and the St. Paul Edison Company; constructing engineer for the Jacques Cartier Electric Company, of Quebec, Canada; chief engineer for Emerson McMillin & Co., of New York City; chief engineer and general manager of the American Light and Traction Company; engineer and manager and afterwards president of the Denver Gas and Electric Light Company.

Mr. Doherty has made many important inventions in connection with the improvement of devices and methods for the production, purification and distribution of gas and improvement in gas-meters and other gas applications. He was the winner of the Beall gold medal awarded by the American Gas Light Association in 1898 and has been a leader in the successful movement in favor of gas for cooking purposes. Mr. Doherty organized the banking house of Henry L. Doherty & Co., and since that time his interest in public utilities has been greatly extended.

FRANK W. FRUEAUFF

FRANK W. FRUEAUFF

In 1891 a young man of seventeen years received his diploma as a graduate of the East Denver High School and thereupon decided that he must continue his educational course while earning his living, and on looking over the business fields of Denver the high-school graduate espied the Denver Consolidated Electric Company, the local representative of a palpably growing industry. So far so good, but the electric concern had no job. The manager consented, however, to take the application, which set forth, among other things, that Frank W. Frueauff was born in Lancaster County, Pennsylvania, March 29, 1874, had lived much of his life in Leadville, Colorado, and had but the previous day graduated from the East Denver High School with an electrical experience of nothing at all. Three months later Mr. Frueauff became a public utility operator with the Denver Electric Company. True, his official title was lamp-boy and his salary $50 a month, but his pathway was already illumined—and by electricity. Today, a little over a quarter century later, finds the always cheerful and efficient lamp-boy the president of the Denver Gas & Electric Company, a worthy successor to his first employer, and partner in one of the largest and most powerful public utility operating firms in the world, Henry L. Doherty & Company, whose success is known in Europe as in America as Cities Service Company. The proverbial ladder of success was climbed rapidly by the young Denverite. From lamp-boy to meter reader, clerk, cashier, secretary and vice-president, and then the presidency, though a voting resident of Garden City, L. I., with business address at 60 Wall Street, New York. But to Colorado Frank Frueauff is still a Denverite, and it was Denver that first remembered his silver anniversary with the electrical industry by tendering roses and congratulations. In 1908 Mr. Frueauff arrived in New York with Henry L. Doherty, who shortly before had successively launched his bark on the sea of independent public utility operation after a remarkable career as chief lieutenant of Emerson McMillin. At that time the office force of Henry L. Doherty Company totaled six, including the firm, and there were four properties operated, of which Denver was easily the leader. Today there are 150 properties in 28 States and 16,000 employees in the Doherty organization, and 250 are employed in the directing offices at 60 Wall Street. Not only are there gas and electric properties, but also immense natural gas and oil industries, and the Doherty emblem even sails the seven seas at the masthead of steamers that carry petroleum products all over the world. From its inception the function of the members of Henry L. Doherty & Company were clearly defined, and Frank W. Frueauff has for a decade been the man behind the guns in the execution of the firm's plans. He worked out the details of the expansion plans when there were but four companies, and he is doing it today. The youth who dealt out incandescent lamps to Denverites is now a recognized figure in the public utility field, with a reputation of possessing a marvelous knowledge of operation and of rates, and an ability in finance that has enlisted the support of some of Wall Street's most powerful houses. This is Mr. Frueauff's achievement in the short time that has elapsed since he first entered the public utility field in a minor position in Denver.

HOLTON HENRY SCOTT

Holton Henry Scott, general manager of operations of Henry L. Doherty & Company, reached his present high place in the public utility field at a comparatively early age. He was born at Orillia, Canada, September 14, 1874, and was taken by his parents to Ashland, Wisconsin, in 1882, where he received his early education. He graduated from the Ashland High School in 1892, subsequently entering the University of Wisconsin, from which he received the B.S. degree upon graduation in 1896. Immediately after leaving college he entered the employment of Henry L. Doherty, who was at that time connected with the Emerson McMillin interests. Mr. Scott's first position was with the Madison (Wis.) Gas & Electric Company. Four years later he went to Lincoln, Neb., as superintendent of the Lincoln Gas & Electric Light Company, and in 1902 left Lincoln for San Antonio, Texas, where he was appointed engineer for the San Antonio Gas & Electric Company, and the San Antonio Traction Company. He subsequently became general superintendent of the former and assistant to the president of the latter, both companies being at that time part of the American Light & Traction Company holdings. In the spring of 1905 he returned to Madison, Wisconsin, as general superintendent of the Madison Gas & Electric Company, and in 1906 went to New York City as chief engineer for Henry L. Doherty & Company, and was engaged in examining all the properties taken over and owned by that company. He is at present general manager of operations for Henry L. Doherty & Company who control 150 public utility, natural gas and oil properties in all parts of the country, and is also a director in many of the corporations owned and controlled by the Doherty interests.

Mr. Scott's activities in the fields of electrical organization led to his election to the presidency of the National Electric Light Association in 1914. He worked assiduously as chairman of the Organization Committee of the Association in making that body, in point of membership, one of the largest, if not the largest, of its kind in the world. During the five years in which he was chairman of the Organization Committee the membership of the Association increased from 3,000 to over 13,000. Mr. Scott was a member of the Executive Committee of the Association for three years, and held a vice-president's rank for two years. He is a member of the National Commercial Gas Association, the New York Electrical Society and the National Electric Light Association, an associate of the American Institute of Electric Engineers, an honorary member of Tau Beta Phi, and a member of the Engineers' Club of New York.

HOLTON H. SCOTT

SAMUEL E. DOANE

SAMUEL EVERETT DOANE

The most important developments in things electrical are creations of the past three decades and many of the most prominent leaders in the electrical field today are among those whose training began in those early years of the industry, not in the technological schools, but in the offices, workshops and laboratories of the great leaders and inventors who created and popularized devices and methods for the use of electricity for the generation of light and power. The training received by those pioneer students of electrical development was intensified by the inspiration and example of the creative geniuses under whom they served, and made practical by constant association with new developments in electrical science. Among those whose training was thus received, one whose career marks an advance from office boy to a place in the electrical world where he is recognized as the most expert electrical lamp manufacturer in the country is Samuel Everett Doane, now chief engineer of the National Lamp Works of the General Electric Company. Mr. Doane was born at Swampscott, Massachusetts, February 28, 1870, the son of Captain Edward E. and Helen M. (Nickerson) Doane. The earliest American ancestor of his name was John Doane, who came from England to the Plymouth Colony in 1629. As can every other descendant of the old Plymouth Colony, whose descendants so largely compose the Sons of the American Revolution and Daughters of the American Revolution and similar Revolutionary and Colonial societies, Mr. Doane can trace his ancestry to several of the members of that pioneer colony which came over on the *Mayflower*. Mr. Doane was graduated from the Swampscott High School in 1886. He had a decided liking for things electrical, and as a high school boy had taken an interest in such work as electric bell wiring, running and operating a Morse Telegraph with a lot of other boys, and similar experiments. In September, 1886, he began business life with the Thomson-Houston Electric Company as office boy for E. W. Rice and Elihu Thomson. He studied under tutors and worked in the testing force or in the laboratory four nights each week for six years, and rose from office boy to acting engineer and assistant foreman of the incandescent lamp department. When, in consequence of the panic, the lamp department at Lynn was shut down in 1892, all of the employees were released but Mr. Doane, who was transferred to the lamp works at Harrison, N. J. He continued in service with the General Electric Company from 1892 to 1893 as assistant engineer of the Harrison Lamp Works; superintendent of the Harrison Lamp Works, 1893 to 1895. and later was acting engineer of the Foreign Department at Schenectady, New York, until 1897. He was superintendent of the Bryan-Marsh Company at Marlboro, Massachusetts, from 1897 to 1900. When the National Electric Lamp Association was formed in 1900 Mr. Doane was delegated to form an Engineering Department. In 1902 Mr. Doane moved to the Ohio headquarters of the new company, which was established at the old Brush plant in Cleveland. Mr. Doane still retains the position of Chief Engineer for the National Works, which is now National Lamp Works of the General Electric Co. His personal success and prominence have been built up by hard work and untiring energy, and he has filled a creative part in the development of the electric lamp industry to its present advanced condition. He is a member of the National Electric Light Association, the American Institute of Electrical Engineers, American Association for the Advancement of Science, Illuminating Engineers Society, Franklin Institute, Industrial Lighting Committee of Ohio, Canadian Electric Association, Association of Car Lighting Engineers, Ohio Electric

Light Association and other State Associations, Ohio Society of Mechanical, Electric and Steam Engineers, Electric League of Cleveland, Rejuvenated Sons of Jove, Engineers Club (New York), Union Club (Cleveland), Cleveland Engineering Society, and Chamber of Commerce, Cleveland. He is an active factor in all the organizations in which he has membership and is influential in all the relations of life. In the electrical profession he is an advocate of the best engineering practice, and of every measure for the advancement of electrical science and the better application of electricity to the uses of life and industry. Outside of his deep interest in his profession, Mr. Doane is a devotee of outdoor sports, with swimming and fishing as prime favorites. During winter he obtains his regular exercise in gymnasium work. Another diversion in which he takes considerable interest and has attained proficiency is the art of photography. Most of his recreational time is spent with his family. Mr. Doane's place of leadership in the incandescent lamp business is that of a specialist who, having found his vocation, has pursued it to a mastery.

A. S. DE VEAU

A. S. De Veau, secretary of Stanley & Patterson, Inc., has been actively engaged in the electrical business for over thirty years. He is a descendant of the Huguenots and was born in New Rochelle, N. Y., October 20, 1866, and, following his education in the public schools there, became an employee of the Westchester Telephone Company, at New Rochelle, in 1887. Following this he became successively employed by the Western Electric Company, of New York City; Pearce & Jones, the Echo Telephone Company, where he was foreman of manufacture, and the Magneto Electric & Manufacturing Company, which succeeded the Echo Company. He was deeply interested in developing the automatic intertalk industry, and in this connection organized the De Veau Telephone Manufacturing Company, of Brooklyn, of which he became president and treasurer. Upon the consolidation of this company with Stanley & Patterson, Inc., he became secretary of the last-

A. S. DE VEAU

named organization and was made director in charge of factory sales. Under Mr. De Veau's direction the De Veau automatic inter-communicating telephone was devised, and this apparatus was adopted largely for local use. Mr. De Veau is a member of the Hardware Club, Brooklyn Club, Forest Park Golf Club, Forest Park, Long Island; the Masonic Fraternity, and is treasurer of the Jovian League. His business address is 23 Murray Street, New York City, and he resides at 1165 East 37th Street, Brooklyn.

ARTHUR L. DOREMUS

ARTHUR LISPENARD DOREMUS

The United States stands pre-eminent in the manufacture of electrical machinery and embraces the whole world in the territory reached by its creations in this line. One of the most prominent men engaged in the distribution of apparatus designed to meet the requirements of electrical science is Arthur L. Doremus, of the Crocker-Wheeler Company. Mr. Doremus was born in New York City, September 3, 1869, the son of the late Professor Robert Ogden Doremus, M.D., LL.D., one of the most distinguished American chemists, who died in 1906 at the age of eighty-two years. His mother was Estelle Emma (Skidmore) Doremus. Mr. Doremus is descended from the Huguenot family Doré, which migrated from France to Holland on account of religious persecution and Latinized the name to Doremus. The family intermarried with the French and Dutch residents of the country of its adoption, and the American branch was established in New Amsterdam and the territory now the State of New Jersey in the seventeenth century. Mr. Doremus is also related on both the paternal and maternal sides to many prominent people, among whom are the Ogden, Haines, Lispenard, Avery and Underhill families. He was educated at MacMullen's School, New York City, and at the College of the City of New York, taking the scientific course at the latter institution and graduating in 1890. Two years later he became an employee of the Crocker-Wheeler Electric Motor Company, now the Crocker-Wheeler Company. This corporation was engaged in the manufacture of motors, dynamos and other electrical machinery, and Mr. Doremus was soon advanced to the position of assistant to the general sales manager. In 1896 he was made secretary in charge of the sales division and in 1904 was elected a director of the company, becoming second vice-president in charge of the sales department the same year while retaining the position of secretary. Being in complete control of the sales division of this great organization, Mr. Doremus devoted his energies to building up a sales system which is notable for its efficiency and completeness. He established nineteen district and branch offices that worked as a unit in covering all demands in an effective way and evolved a policy to keep them in constant touch with the main office. Mr. Doremus is a close student of human nature, and his success in perfecting the sales organization for the Crocker-Wheeler Company was in a measure due to his selection of his assistants, the personnel of the office being of such a character that success, as a matter of course, followed its efforts. In addition to his connection with the Crocker-Wheeler Company, Mr. Doremus is a director of the Canadian Crocker-Wheeler Company. He gained wide experience in all lines of electrical work through his travels in the interest of the company, whose foreign business called him to England, Scotland, Germany, Holland, Belgium and Italy. He was later transferred to executive duties as a vice-president and district manager at New York City, where he is also in charge of the export department, which is constantly increasing under his direction. Mr. Doremus is a Republican in politics and was chairman of his district for five years after the reorganization of the party under the Committee of Thirty. He is unmarried and is a member of the Railroad Club, Machinery Club, New York Athletic Club, Atlantic Yacht Club, New York Electrical Society and the Electric Power Club. He was elected president of the New York Electrical Society in 1918. His religious affiliations are with the Dutch Reformed Church in America—the religion of his forefathers. Mr. Doremus resides at 31 East 30th Street and his offices are in the Hudson Terminal Building, 30 Church Street, New York City.

WASHINGTON DEVEREUX

Long and influential association with the electrical industry has made the name of Washington Devereux well known to the electrical profession. He was born in Philadelphia, February 9, 1863, descendant of an old colonial family of French and Irish origins, and of ancestors who fought in the New Jersey and Pennsylvania battles of the Revolutionary War. He was graduated from Girard College in 1878, and took special courses in mathematics and literature. He always had an inclination toward scientific study and research, and this led him into a connection with telephony, then in its infancy, becoming connected, June 1, 1880, with the Bell Telephone Company of Pennsylvania.

Later he was with the Central Pennsylvania Telegraph and Telephone Company, in charge of the Bloomsburg Division from Northumberland to Kingston, installing the first systems of telephones in Columbia County, Pennsylvania, and building lines connecting up various towns along the West Branch of the Susquehanna River. After that he was with the Jurugua Railway and Mining Company of Cuba, installing systems of Telegraph and Telephones from Santiago de Cuba to El Caney, Sibonay, Jurugua-Cedars and Firmaza; and later with Walker & Kepler, electrical engineers of Philadelphia, engaged in construction and installation of electric light and power equipments. From that connection he went to his present position as chief of the electrical department of the Philadelphia Fire Underwriters' Association.

Mr. Devereux is past vice-president of the Engineers' Club of Philadelphia; associate member of the American Institute of Electrical Engineers; member of the National Electric Light Association (Class B), American Electrochemical Society, Illuminating Engineering Society, associate member National Fire Prevention Association (member of its Electrical and Uniformity Committees), president of National Inspectors' Association, chairman Philadelphia Electrical Conference, member Electrical League of Philadelphia, Electrical Council of Underwriters' Laboratories, Inc.; Fire Insurance Society of Philadelphia, and is chairman of the Electrical Section, Insurance Institute of America. He is also a member of the Athletic Club of Philadelphia, Business Science Club, and Girard College Alumni Association and Past Tribune of the Jovian Order, honorary member International Association of Municipal Electricians and member of the Western Association of Electrical Inspectors.

PAUL M. DOWNING

The life work of Paul M. Downing has been very intimately associated with the development of the hydro-electrical industry in Californnia, where his accomplishments have been of such consequence to the industry as to have won him a fine reputation. He is now the chief engineer of the Electric Department of the Pacific Gas & Electric Company at San Francisco, with which company he has been connected since 1901, serving them in several capacities prior to being advanced to his present position. Mr. Downing, though born in Newark, Missouri, Nov. 27, 1873, went to California as a youth to secure an education at Leland Stanford University. During his college days he was prominent on the varsity football team, of which he was captain in 1894, and he was a member of the Sigma Nu fraternity. After being graduated in 1895, and, having prepared himself by electrical engineering studies, he entered the practical field of his chosen profession, becoming a dynamo tender with the Tacoma Light & Power Company of Tacoma, Washington. But he soon returned to California to serve the Market Street Railway Company of San Francisco as a power house operator, and later to fill a similar position with the Blue Lakes Water Company of Jackson, Calif. His next occupation, and the last before he joined the Pacific Gas & Elecric Co., was as electrician with the Standard Consolidated Mining Company of Bodie, Calif. Mr. Downing is a member of the Engineers' Club, Commonwealth Club and Olympic Club of San Francisco, the local branches of the National Electric Light Association and the American Institute of Electrical Engineers, and the Masonic Blue Lodge, including Chapter, Shrine and Commandery.

FRANK L. DAME

FRANK L. DAME

Frank L. Dame, well known in the public utility field, was born in Boston, Mass., March 21, 1867. After a varied early school experience in New York, Chicago and Michigan, he returned to Boston and after going through the English High School there, graduated from the Massachusetts Institute of Technology in 1889, with the degree of B.S., in Electrical Engineering. In the last two institutions he took a leading part in military organizations and as a member of the football teams.

In September, 1889, in the old shop in Garrison Alley, Pittsburgh, he began his business career in the testing room of the Westinghouse Electric Company. After about thirty days his first construction assignment was made at Newburgh, N. Y., and in December, 1889, he reached Portland, Oregon, as the Engineer of that office of the Westinghouse Company. A year later the company's financial troubles caused the closing of the Portland office among others and Mr. Dame operated the Vancouver (B. C.) Railway & Light Company, with the title of General Superintendent, for a year. The end of 1891 found him again located in Portland as Engineer of the Lighting Department of the Northwest Thomson-Houston Electric Company. In the following two years he was also active in street railway construction, and with the replacement of equipment in several Oregon and Washington cities. This was the beginning of an association of twenty-one years with the General Electric Company in various capacities, during which he was successively General Manager of the Seattle Consolidated Street Railway; General Superintendent of the Tacoma Railway & Motor Company and its associated companies; General Manager Union Electric Company, which was engaged in railway operation and lighting in Dubuque, Iowa; Engineer of the Committee on Local Companies (supervising local public utility interests then controlled by the General Electric Company); and concurrently with the last position he was Engineer of the Electric Securities Corporation, finally being chosen vice-president of the Electric Bond and Share Company. This period covered construction, reconstruction, development management and financing of various utilities and many official connections with corporations not enumerated. In Tacoma, Mr. Dame had a disagreeable personal experience with a train robber of some note, which, although he was more fortunate than the bandit, left him with a crippled left arm. The last important work in this period was the field work of purchasing and getting together the various power companies in Utah and Idaho for consolidation with the Telluride Power Company to form the Utah Power and Light Company in the latter half of 1912.

Feeling that he needed a rest, Mr. Dame severed his connection with the Electric Bond & Share Company, at the end of 1912, and succeeded in taking a partial vacation during the next eight months, at the end of which time he took up his present connection with the Harrison Williams interests. At the present time Mr. Dame is president and director of the Central States Electric Corporation and the Electric Investment Corporation; vice-president and director of the Mahoning & Shenango Railway & Light Company, the General Vehicle Company, the Utilities Securities Corporation, Republic Engineers, Inc., and Federal Utilities, Inc., and a director of the Republic Railway & Light Company and the Peerless Truck and Motor Corporation. As a dollar-a-year man he devoted his energies to the nation in the Facilities Division of the War Industrial Board. He is a member of various trade organizations and societies and of the Bankers' Club of America, the Cherry Valley Club, the Garden City Country Club and the Engineers' Club. Mr. Dame was married in 1906 to Mary E. Elvidge and with their two sons, Mr. and Mrs. Dame now reside at 79 Oxford Boulevard, Garden City, L. I. His New York offices are in the Columbia Trust Building, 60 Broadway.

DOUBLEDAY-HILL ELECTRIC COMPANY

The Doubleday-Hill Electric Company, of Pittsburgh, manufacturers and distributors of electrical appliances and supplies, commenced business in April, 1897, as a partnership between H. M. Doubleday, C. Phillips Hill, G. Brown Hill, and H. G. Shaler, succeeding the Electrical Supply & Construction Co., of which H. M. Doubleday was president. The Electrical Supply & Construction Co., together with the North American Construction Co., began business February 1, 1890, being a consolidation of the Keystone Construction Co. and the Marr Construction Co. These companies were engaged in the sale and installation of electric light and street railway plants throughout the United States and part of South America. The officers were James S. Humbird, George H. Baxter, E. H. Wells, R. D. McGonigle, Frank S. Marr, H. M. Doubleday, Thomas Spencer and E. K. Keller. A number of these men, including Mr. Doubleday, were at one time associated with Thomas A. Edison.

C. PHILLIPS HILL

G. BROWN HILL

The partnership was incorporated in 1906, with C. Phillips Hill, president; G. Brown Hill, vice-president-treasurer, and H. G. Shaler, secretary and sales manager. In addition to these officers the board of directors includes G. Frank Slocum and Elliott Reynolds. Subsequent to 1906 W. D. Shaler was made secretary; G. Frank Slocum is now filling the position. The building occupied by the Company, intersection Liberty and Wood streets, Pittsburgh, contains ten floors devoted to electrical material of every description, manufacturing and repairing. Its warehouse and offices, located in 715 12th street, Washington, D. C., contains four floors utilized in the same manner. These stocks are composed of materials absolutely essential for the needs of industrial plants, lighting stations, telephone companies, electric railroads and contractors. The Company manufactures armature and field coils, commutators, switchboards, etc. A service station is maintained in 5952-54 Baum Boulevard, Pittsburgh.

FRANK L. DRIVER

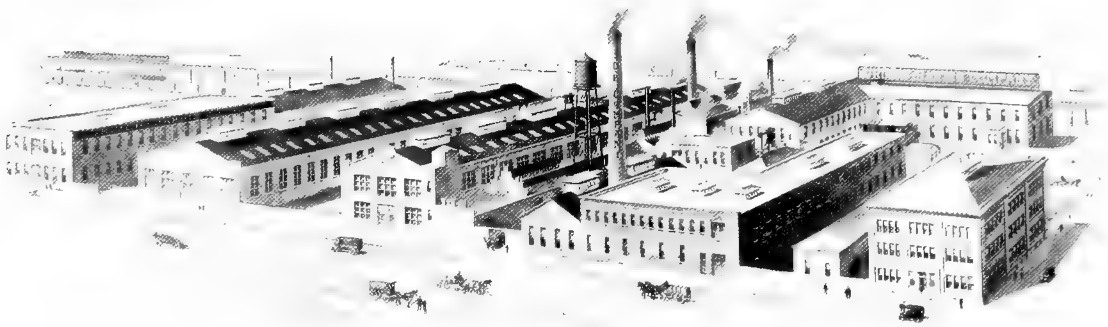
FRANK L. DRIVER

Frank L. Driver, who in addition to his interest in the Driver-Harris Company, of Harrison, New Jersey, of which he is president, is active in the civic and political affairs of Essex County, N. J., was born in New York City July 4, 1870. His education was obtained in the public schools of Brooklyn, and after graduation in 1888 he was associated with mercantile concerns until October, 1898, when he became the partner of his brother in the firm of Wilbur B. Driver & Company, at 126 Liberty Street, New York City. They acted as selling agents for several specialties manufactured by the John A. Roebling's Sons Company, which they bought and sold on their own account. At this period German silver and a nickel-steel alloy were the only materials on the market, classed as "Resistors," and neither of them filled the requirements of the manufacturers of electrical apparatus. The demand for special alloys for particular uses was growing rapidly and the members of the firm realized there were great commercial benefits to be derived in meeting that demand. After giving the subject considerable thought, the Driver-Harris Wire Company was organized and incorporated in 1900. The company began manufacturing in a small building in Newark, N. J., and the venture was so successful that in 1902 the factory was removed to Harrison, N. J., and from that small beginning the present large plant has developed. Since entering the manufacturing field, the Driver-Harris Company has developed several alloys that are used, generally, by many manufacturers, and these alloys are well-known today among makers of electrical apparatus and devices, both in the United States and many foreign countries. "Nichrome," one of the company's products, is used extensively in electrical heating work and in addition, a number of alloys in wire and sheet form are being manufactured. These are designed to meet many demands. Mr. Driver, who is very active in the company's affairs, finds time to devote to civic matters and occasionally indulge in politics. He is ex-president of the Newark Shade Tree Commission, ex-member of the Essex County Board of Chosen Freeholders, second vice-president of the Associated Automobile Clubs of Newark, N. J., a director of the New Jersey Life Insurance Company and a member of the Jovian Order, the Cranford Golf Club and the Detroit Athletic Club. Mr. Driver's business address is Harrison, N. J., and he resides at 311 Mt. Prospect Ave., Newark, N. J. While the success of the Driver-Harris Wire Company is in a measure due to the excellence of its products, credit must be given Mr. Driver for his unceasing labor in extending the company's trade and for the executive ability that has enabled him to direct the constantly increasing business along economic and efficiency lines.

DRIVER-HARRIS COMPANY

The Driver-Harris Company, established in Newark in 1900, under the style of Driver-Harris Wire Company, has in a short time made possible marked improvements in electric apparatus, and has advanced the state of the electric art to a very marked degree.

From the beginning, this Company has been successful and grown consistently. Today, the plant at Harrison, a suburb of Newark, covers an area of about 3½ acres and employs about 800 people.



The policy of the Company has been to develop alloys showing characteristics desired for particular type of apparatus. As an example, the well-known series of Nickel-Chrome alloys, ("Nichrome") commercially developed by this Company, has made possible tremendous advances in electric heating devices. Previous to the introduction of "Nichrome" the electric heater was short-lived, but as a result of the dependability secured by the use of "Nichrome" for resistors and heaters, a tremendous demand has been filled, not only for domestic heating appliances, but for many large and important industrial applications, such as electrically heated gun hardening furnaces, automobile enameling and drying ovens and uses requiring heating units of large capacity.

The Company now produces "Nichrome," Kromore, Climax, Advance, Therlo and No. 193 Alloy. In this range of materials may be found a suitable alloy for every type of electric heating and control apparatus, precision measuring instruments, electrodes for spark plugs and materials resistant to acids and alkalies.

The most important development of the Company has been the production of a line of cast products, able to withstand prolonged periods of high temperature, without warping, scaling or losing their original form. This patented, cast product, marketed under the name of "Nichrome," has caused marked economy in the industries and found favor for carborizing and annealing boxes, rotary retorts, lead and cyanide containers, pyrometer protection tubes, special furnace parts and brass melting crucibles.

In addition to the materials mentioned above, the Company is now manufacturing pure sheet nickel, nickel wire (rod and strip), wire rope, fine brass wire, cords for electric heating apparatus and cold rolled strip steel.

During the past year a business of about \$4,000,000 has been done. The authorized capital of the Company is \$1,300,000, of which \$1,236,500 has been issued. Its officers are as follows: F. L. Driver, President; Arlington Bensel, First Vice-President; L. O. Hart, Second Vice-President; F. L. Driver, Jr., Third Vice-President; P. E. Reeves, Treasurer; S. M. Tracy, Assistant Treasurer; M. C. Harris, Secretary.

WILBUR B. DRIVER

WILBUR B. DRIVER

Wilbur B. Driver, vice-president of the Driver-Harris Company, of Harrison, New Jersey, who has devoted many years to the development of material used in the electrical field and various arts, was born in New York, April 26, 1874, and was educated in the public schools and High School of Brooklyn. His first occupation, as a boy, was with a New York dry goods importing house. He left this position on account of ill health and entered a lawyer's office, where among other work, he wrote down the testimony of Dr. Edward Weston which was given in the litigation over the Brush double carbon arc lamp. This suit doubtlessly led his thoughts to electrical matters, for he soon concluded that he did not have sufficient education to take up the study of law and his next position was with the Edison General Electric Company. Here his duties were merely to carry the mails from the Post Office to the company's headquarters at 44 Broad Street and distribute the matter throughout the building. He was subsequently employed in the advertising and stationery departments of the company and upon the consolidation of the Edison General Electric Company with the Thomson-Houston Electric Company, he went to Schenectady, to which city the offices were removed, and for a period worked in the collection and purchasing departments. This connection did not give Mr. Driver the practical work he desired so he resigned in 1893, and returning to New York, entered the employ of Patterson, Gottfrid & Hunter, for which firm he acted as buyer for three years. Previous to this time he had done some reading on electrical subjects and when it became necessary to buy some resistance wire for the General Incandescent Arc Light Company, he was the only man in the employment of the firm who had any knowledge of such electrical matters. He both bought and sold nickel-steel wire, devoting to this line such time as he was able to take from his other duties. He gave especial attention to the resistance wire business and tried to induce the Patterson, Gottfrid & Hunter people to relieve him of other work in order that he could devote all his time to this line. The firm did not agree to the proposition and Mr. Driver made arrangements with the John A. Roebling Sons Company to manufacture the goods for him individually. This agreement continued for one year when the Roeblings decided the business was too small for them and Mr. Driver believed that they were not handling his orders in a proper manner. They agreed, however, to continue manufacturing for Mr. Driver, and, as he had practically no capital, the offer to consign him a stock of wire was a magnanimous one. This was in 1898, and Mr. Driver at once formed a partnership with his brother, Frank L. Driver, under the firm name of Wilbur B. Driver & Company, with offices at 126 Liberty Street, New York City. The two brothers devoted themselves to the sale of nickel-steel wire, under the name of "Climax," but finding it necessary to furnish other grades of resistance material, they broadened their lines, and on January 1, 1900, formed a corporation under the name of the Driver-Harris Wire Company, of which Mr. Driver became president, continuing as such until April 1, 1905, when he disposed of his interest and devoted his time to experimental work on resistance wires. In 1914, he again acquired an interest in the company and is now vice-president. Mr. Driver's only hobby is his business. He likes to feel that some achievements have been made possible because of work which he has been able to do, even though these things may not show themselves to the general public. His technical knowledge has been acquired by self-instruction and in the school of experience, and this has been freely utilized for the advancement of electrical science. He is a member of the American Foundry Association and the American Electrochemical Society.

D. CLARENCE DURLAND

D. C. Durland, president of the Mitchell Motors Company, Inc., graduated from Princeton University as an Electrical Engineer in 1894 and immediately afterward became connected with the Interior Conduit & Insulation Company, of which M. E. H. Johnson was president, and was associated with him and Mr. Robert Lundell in the development of the Lundell fan motors, power motors and various industrial applications of same, and with Mr. Edwin T. Greenfield in the development of the interior conduit system for wiring buildings. Later the Interior Conduit System was consolidated with the Sprague Elevator Company, under the name of the Sprague Electric Company, of which Mr. Durland became assistant general manager. This company carried forward the electrical apparatus and conduit business of

the Interior Conduit Company and the elevator business of the Sprague Elevator Company and successfully developed the Sprague Multiple System Unit of Control. In 1902 the General Electric Company purchased the Sprague Electric Company, since operated as a subsidiary manufacturing and selling organization of the General Electric Company, of which Mr. Durland was placed in executive charge as General Manager, a position he retained until becoming president of the Mitchell Motors Company, Inc. Mr. Durland is a member of the Electrical Manufacturers' Club, the Electric Power Club and the Associated Manufacturers of Electric Supplies, of which he was one of the organizers. He is also a director and vice-president of the Entz Motor Patents Corporation; director, secretary and treasurer of the Owen Magnetic Motor Car Corporation; director and vice-president of the Baker R. & L. Company, Cleveland, Ohio, and director of the Sibley & Pitman Electric Company.

DR. LOUIS DUNCAN

Dr. Louis Duncan, most worthy of a place in the annals of Electricity and who died February 13, 1916, was one of the leading electrical and consulting engineers of his time. He was born in Washington, D. C., March 25, 1861, the son of Rev. Thomas and Maria L. (Morris) Duncan. The father was of Scottish ancestry, the American branch being founded by Thomas Duncan, who came from Perthshire in 1740 and settled in the Cumberland Valley. The mother was the daughter of Commodore Charles Morris, U. S. N. Dr. Duncan was educated in the country schools of Maryland, Virginia and Tennessee, after which he was a student at the East Tennessee University for one year, when he was appointed to the United States Naval Academy and graduated in 1880, twenty-third in his class. After a two-year cruise on the Pacific Station, he passed the Ensign examination first in his class, and was then detailed to Johns Hopkins University to assist in the work of determining the absolute unit of electrical resistance, for the U. S. Government. For this work he was awarded the Ph.D. degree by the university in 1885. He resigned from the Navy in 1886 and occupied the Chair of Electricity at Johns Hopkins until 1899, during which time he was engaged in the construction of electrical roads in Baltimore and was consulting engineer for practically all of the electric roads in Washington. He was also engineer for the Baltimore and Ohio Railroad Company and installed the 100-ton electric locomotives which haul trains through the Baltimore tunnel. Resigning from Johns Hopkins in 1899, he became chief engineer of the Third Avenue Railway, New York, and was in charge of the electrical construction of that system. In 1902 he received a call from the Massachusetts Institute of Technology and inaugurated the Electrical Engineering Course, remaining as head of the electrical engineering department until his resignation in 1904. Organizing the firm of Sprague, Duncan & Hutchinson, he became consulting engineer for the New York Rapid Transit Commission on the first subway, and Chief Engineer for the Keystone Telephone Company of Philadelphia and of the independent telephone systems in Baltimore and Pittsburgh.

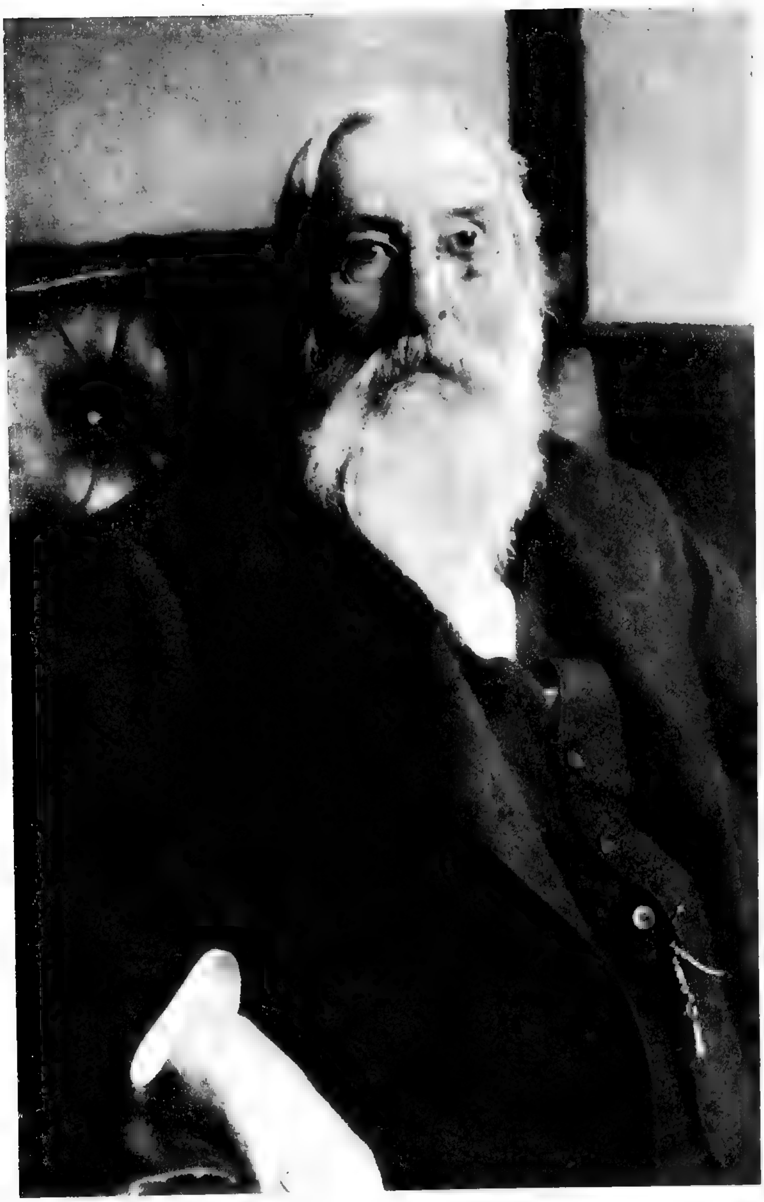
He was chairman of the Board of Judges at the Philadelphia Electrical Exhibition in 1885, a member of the Board of Judges at the Atlanta Exposition, the World's Fair at Chicago and Chairman of the Electric Railroad Section of the St. Louis Exposition. He contributed articles on Electric Traction to the 10th and 11th editions of the Encyclopedia Britannica and was the author of many scientific papers. He was Lieut. Commander in the Maryland Naval Reserve and at the outbreak of the Spanish-American War was appointed Major of the First Battalion of the First Regiment of Volunteer Engineers. He was a member of the New York Commandery of the Naval Militia Order of the Spanish-American War; the Officers' Association of the First Regiment of Volunteer Engineers; a Fellow of the American Institute of Electrical Engineers and twice its President, 1895-7; a member

DR. LOUIS DUNCAN (Deceased)

of the American Electrochemical Society; an Honorary Member of the Franklin Institute and an Associate Editor of its Journal; a member of Société Mathematique de France; a member of the Société de Physique, and of many other learned and technical societies in America and Europe.

He was a member of the Phi Beta Kappa Society; of the Maryland Club, the Baltimore Club (Baltimore), the University Club (New York and Baltimore), the Army and Navy Club (New York and Washington), the Engineers' Club (New York), and Waverly Lodge 152 A. F. & A. M.

In 1889 he married Edith Smith McKee, of Philadelphia, the daughter of James H. and Mary Thomas McKee, of Hockendauqua, Pa., and had four children: McKee Duncan, Mrs. Dorothy Duncan Wadsworth, Mrs. Harriet Duncan Gillett and Miss Edith Duncan.



AUSTIN C. DUNHAM

AUSTIN C. DUNHAM*

The development of electrical activities and industries which has been going on for the past three or four decades has been so wonderful and so rapid that it would seem as though there was but little more left to know about it. Yet those who know it best are unanimous in the opinion that electricity is in its infancy so far as the scope of its uses to human society are concerned. One of those holding this opinion is Austin C. Dunham, than whom few have been longer active in the electrical field, and none more usefully. He has lived more than fourscore years, having been born on June 10, 1833, in South Coventry, Tolland County, Connecticut. But he is of an old Connecticut family, many members of which have been distinguished by remarkable longevity. His ancestry dates back to the first Chief Justice of Connecticut, who was also a Colonel in the Revolutionary Army and a member of the First Continental Convention. There were also three great-uncles of Mr. Dunham whose average lives were 100 years and who all served in the Revolutionary Army. Mr. Dunham was educated in private schools and at Yale University, from which he was graduated A.B. in 1854 and pursued specially advanced studies in higher mathematics and in Greek. He was initiated into Psi Upsilon while in college. His first employment after graduation was as teacher in a school at Elmira, N. Y., in 1855, and afterwards he embarked in business as a manufacturer of wool and cotton goods, which he prosecuted with success for years. At that time electricity meant practically nothing in the active life of the people outside of such use as was made of it in connection with telegraphy. It was at the Centennial Exhibition in Philadelphia that public interest was first aroused to any important degree in this country. After that it took on increasing importance. One of the enterprises that started up was the Thomson-Houston Company, which began in a small plant at New Britain, Conn. In that company Mr. Dunham became a director. His acquaintance with Professor Elihu Thomson began at that time and with it an immediate and growing interest in electrical work. In 1882 his connection with electrical problems became strongly fixed by his being made President of the Hartford Electric Company, and he held that position for thirty years. It was in a condition of bankruptcy when Mr. Dunham took hold of it in 1882, and he built it up to a market value of $9,000,000 in 1912. His administration was a model of efficiency, both in equipment and management and in keeping pace with the advance in electrical science. Mr. Dunham is a man of culture and learning, a writer of vigor and conviction and has all his life been a student of the facts and well-founded theories of scientific progress. Professor Tyndall's discovery that heat was a form of motion led him to think of electricity as well as, perhaps, light as being of the same characteristic and peculiar efficiency. The discovery that electric current could be developed on one dynamo and communicated through a wire to another dynamo at a distance, being changed in the process into power, opened the way for the conversion of electricity into any form of use in connection with power. So that the process of development of the uses of the current largely depended upon the cost of power, and any method which led to a greater use of the current from a decline in its cost, or from the application of the current by being able to get greater results from the same power, made electric current one of the most useful means of utilizing human labor. Mr. Dunham, who has developed and made practical as many electrical novelties as any contemporary, has during the past thirty years seen the horse-power, in cost for developing light and power, decline from three cents to four mills per hour, with a parallel decline in the cost of labor, though labor cost is affected by other things, such as new inventions, greater efficiency in its application, etc., so that the entire decline in cost of labor is not chargeable to cost of power. Mr. Dunham holds the momentous opinion that we are on the eve of a very great revolution in the use of fuel and in the development of electric current in relation to its uses for transmission and all other forms of service in human society.

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*Mr. Dunham died at St. Petersburg, Florida, on March 18th, 1918.

THOMAS ALVA EDISON

Thomas Alva Edison was born at Milan, O., February 11, 1847. The family was originally of Dutch descent settled in New Jersey; and the name of Thomas Edison as a bank official on Manhattan Island was signed to Continental currency in 1778. The Loyalist movement carried his descendants to Nova Scotia, where Edison's father was born in 1804. This Samuel Edison settled at Vienna, Ont., married Miss Nancy Elliott, a Yankee schoolmarm, in 1828, and Thomas Alva was one of the three children from this marriage. Samuel was both a physical giant and an ardent politician. Becoming a captain of insurgent forces in the Papineau-Mackenzie rebellion, he was forced to flee Canada for his health, seeking refuge in Ohio, where his wife joined him. Young Edison had very little schooling, but owed nearly all his early education to his mother, an attractive and highly cultured woman. In 1854 the family moved to Port Huron, Mich., where Edison developed studious habits, became a great reader, especially in natural science, and established a miniature chemical laboratory—his first in a long series—in the domestic cellar. Only twelve years old, with an eye to the unlimited perusal of newspapers and magazines, Edison secured a job as newsboy and "candy butcher" on the Grand Trunk Railway, between Port Huron and Detroit. On these trains he set up a laboratory, which was soon ejected, but was probably the first ever installed in a moving car. In 1862 he also printed and published a little journal, "The Weekly Herald," on the train, undoubtedly the first thus issued. The same year, he saved from death on the track the tiny son of the station agent at Mount Clemens, Mich., and the grateful father undertook to teach Edison telegraphy. The same year also Edison put up a telegraph line from the Port Huron depot to the village and worked in the local office; and in 1863 he secured his first position as a regular telegraph operator, on the Grank Trunk, at Stratford Junction, Canada. During the five following years he roamed the Central West and South as an operator, reading and experimenting; and in 1868 he went to Boston and entered the Western Union telegraph office. In 1868 he devoted himself largely to experiments on duplex telegraphy, went into private line construction and took out his first patent, an electrical vote recorder, which an unappreciative Congress never deigned to adopt, although the idea has since been quite generally accepted.

1869 found Edison in New York City, playing in hard luck, until he happened casually to repair apparatus for the Gold & Stock Telegraph Company, winning thereby the position of superintendent at $300 per month. He proceeded immediately to improve and invent stock tickers which met with prompt adoption, but also formed with F. L. Pope a firm of "electrical engineers," which inserted in a telegraphic journal the first professional "ad" for that branch of expert work. Receiving no less than $40,000 cash for some of his inventions in 1870, he opened an electrical factory in Newark, N. J., where he manufactured tickers, etc., and where he helped Sholes, the inventor of the typewriter, to produce a working machine. Already attracting attention by his ingenuity, versatility, and boundless energy, he now became famous a year or two later with his useful quadruplex telegraph system; and this was followed up in quick succession with various telegraphs—automatic, multiplex, sextuplex, duplex—the motograph, carbon rheostat, microtasimeter, etc., not forgetting the paraffin paper now in such universal use for wrapping purposes.

In 1876, Edison moved his shop and laboratory from Newark to Menlo Park, N. J., and signalized the event shortly after by inventing his famous carbon telephone transmitter, which had so great an influence in the development of the art of speech transmission. But not satisfied with transmitting speech, Edison immediately, in 1877, invented the phonograph, which for the first time in human history recorded vocal speech and instrumental sounds for reproduction. This great

Eng by E G Williams & Bro NY

Thos A Edison

achievement literally carried Edison's name around the world. His patent for the phonograph was granted two months after application without a single anticipatory reference.

During 1878, Edison began seriously to devote thought and experience to the problem of obtaining light from electricity, and pursued his investigations with sleepless, unremitting effort. Arc lamps of large candlepower illumination were known, but what he proposed was to overcome the difficulties regarded as insuperable in the "subdivision of the electric light," so that a small unit like the gas jet, the tallow candle, or the oil lamp would be available on even terms of competition. As usual, Edison was not to be denied, and on October 21, 1879, his invention of the incandescent electric lamp was perfected. That day, after laborious efforts, he carbonized a piece of cotton sewing thread bent into a horseshoe loop, sealed it in a glass bulb from which air had been exhausted up to one-millionth of an atmosphere, put it in circuit, lit it up to bright incandescence, and kept it intact for over forty hours. This carbon filament lamp possessed the characteristics of high resistance and small radiating surface, permitting economy in the outlay for conductors of the current, and needing only a minute amount of electrical energy for each lamp or unit of light. "This slender, fragile, tenuous thread of brittle carbon, glowing steadily and continuously with a soft light agreeable to the eyes, was the tiny key that opened the door to a world revolutionized in its interior illumination" —and its exterior illumination as well.

But the lamp was by no means all. Many other practical elements were required for a complete system of illumination by incandescent lamps, and to these Edison turned his attention without delay, notably dynamos of low internal resistance, systems of distribution and regulation, meters, switches, sockets, safety fuses, and an immense variety of devices, all still persisting in the art in improved or perfected form, but fundamentally unchanged. On December 31, 1879, Edison gave a public demonstration of his system in Menlo Park, to which special trains over the Pennsylvania Railroad carried 3,000 persons to see hundreds of the little lamps burning serenely in the buildings and streets, all fed with current from underground circuits. Thereupon steps were taken to exploit the system commercially, offices were opened, and great factories and shops were established for the production of the apparatus, including the first large incandescent lamp factory at Harrison, N. J. On September 4, 1882, the first central Edison Station in New York City went into operation, and in 1883 the first three-wire station was installed at Sunbury, Pa. A period of strenuous activity ensued, lasting up to 1887, and closing roughly with the removal of Edison's laboratory to Orange, N. J. Through the whole decade, 1878-88, electric lighting improvements were foremost in Edison's thoughts; but meantime other lines of invention were touched by the life-giving breath of his genius.

As far back as 1880, Edison worked out his ideas as to a magnetic ore separator, but for nearly ten years he was not able to secure time or opportunity for its use. One reason aside from his work on the phonograph, electric lighting, etc., was that he grappled with the serious problems involved in the application of the electric motor to traction, and developed many inventions in that new field. In 1880-2 he invented and installed a complete electric railway for freight and passengers at Menlo Park, the demonstrations with which did much to foster the new art and to enlist capital for its development. His interest in the subject continued, and in 1891 he made a number of further inventions aimed at supply of current from the roadbed, so as to dispense with the overhead trolley wires, which in those days of immaturity were the cause of many serious accidents from frequent breakage, and were subject to incessant interruption of service. Once again Edison returned to this field after the introduction of his alkaline storage battery, which was applied to street-car operation. Edison is still strong in the belief that the self-contained car is at least one satisfactory solution of the traction problem, while he has lived to see and help make the electric vehicle a formidable rival of the gasoline automobile.

Though Edison's endeavors in magnetic ore concentration have not been attended with the brilliant success and beneficent results that mark his work in other branches of industry and mechanics, they are none the less worthy of him and will ever constitute a monument to his inventive skill and inexhaustible courage.

From 1891 to 1901 he gave much of his time and more money than he could spare to his great iron ore-crushing and separation plant among the hills of western New Jersey. He developed any number of novel methods and ingenious devices for use at every stage of the process, from the giant rolls for smashing up huge masses of magnetic ore rock and the three-high rolls for fine crushing, to the magnets for separating the particles of iron from the worthless gangue, and the concentration of the iron ore dust into briquettes. Some idea of the grand scale on which Edison did things may be derived from the fact that he acquired no less than 16,000 acres of magnetic ore deposits, enough to take care of the whole United States iron trade for many years; and that around his mills, at Edison, N. J., he had over 200,000,000 tons of such low-grade ore to treat. There was a ready market for all he could produce, and one early order was for 100,000 tons. But just at this junction the great desposits of rich Bessemer ore in the Mesaba range of Minnesota became available, and no living man could meet the competition of this wonderful largesse of Nature. Edison must perforce abandon the adventure into which he had poured millions of dollars, with the conviction that he was right in the long run. He merely said: "It's all gone, but we had a hell of a good time spending it," and forthwith he turned around, applied all his hard-won knowledge to the cement industry, introduced a number of leading innovations and became one of the largest manufacturers of cement in the world! Very few men could do that. A further derivation of this line of application has been his system for fabricating cement houses with a set of iron molds. The permutations of the molds give variety of structure and architecture, and the houses can be poured cheaply, swiftly and endlessly.

Preceding much of this came the Edison invention of the picture camera in 1891, and here again were laid the foundations of an entirely new art. With this mechanism and the ribbon film began the era of the motion picture, with its marvellous creation of innumerable new places of amusement, new employment for brains and capital, and not least a profound effect upon the theatre and the drama, of which the final evolution is not yet in sight. Moreover, as early as 1887 this radical departure carried with it the implication of the talking motion picture, elaborated in 1912 in the "kinetophone." With this, extraordinary results have been obtained from the exact synchronism of phonograph and motion picture film, only believable when seen and heard as they have already been by many thousands of people.

Throughout the first decade of the twentieth century the inventor made many other advances. It is one of the peculiarities of his method of working that while he always has several irons in the fire, he will now and then cease active work on a special subject, and when he seems to have forgotten it, go back with new zest and an accumulation of fresh ideas about it. To this period belong a new phonographic dictating machine in 1905, a new electric motor for operating phonographs in 1907, and then the present Edison disc phonograph with diamond point producer and indestructible records of special composition. About this time came the telescribe, a device by which both "ends" of a telephone conversation are recorded on a phonograph; and of kindred character is the "transophone," a transcriber's dictating machine which is operated electrically from the keyboard of the typewriter. Beyond all these, lie many other inventions such as those relating to wireless telegraphy and telephony with a static system, tried out long before the days of Marconi, and used successfully between moving trains and the adjacent pole line wires. The Edison primary battery is in large use, particularly in railroad service. Edison has long pondered over the difficulties of the direct conversion of heat into electricity, and has many ingenious thermomagnetic motors and generators to his credit. Of late since the outbreak of the Great War and his ap-

pointment as head of the Naval Consulting Board, Mr. Edison has devoted himself quite largely to military and naval problems, such, for example, as those connected with the suppression of the submarine boat. Nothing can be said in detail just now as to all this work, but it may be remarked that his wonted ingenuity and inventive resourcefulness have been as ready as ever.

Mr. Edison has always had a passionate love of chemistry, and all his life has followed its development so closely that electricity might be said to be relegated to a second place. His profound chemical knowledge stood him in good stead in 1914 when the supply of carbolic acid from Europe was cut off by the war. He proceeded immediately to make the acid, synthetically produced it in 18 days and within a month was able to turn out a ton a day. Dependent on benzol for this synthetic process, he next found the supply of that very precarious; and thereupon proceeded to erect and operate great benzol plants in this country and Canada, from which adequate supplies are now secured of benzol, toluol, solvent naphtha, naphthaline and xylol. The crying needs of the rubber and textile industries for myrbane, aniline oil and aniline salt next came to his notice, and a plant was soon put in operation to meet these demands. In sequence to this arose the shortage in the fur industries of paraphenylenediamine, hitherto obtained from abroad; and once more Edison came to the rescue. And thus it has gone on, so that it would be hard to say just what is the latest "drive" into the chemical industries that Edison has made on his own initiative or in response to urgent appeals.

Edison has received innumerable degrees and marks of recognition, the latter including the Albert gold medal of the Royal Society of Arts of England and the John Fritz gold medal of the four national engineering societies of America. The Edison gold medal was founded in the American Institute of Electrical Engineers in 1904 and has since been awarded to several great electrical engineers and scientists. Various organizations bear his name, notably the Association of Edison Illuminating Companies. In 1918, on his birthday, the Edison Pioneers, whose membership is composed of men associated with him in his work and enterprises up to 1885, was founded. Mr. Edison is a member—honorary in several instances—of a great number of societies, and though in no sense a club man, is an honorary member of the Engineers' Club of New York.

EVAN J. EDWARDS

Evan J. Edwards, electrical engineer and educator, born in Williamsburg, Iowa, March 3, 1882, was graduated from the State University of Iowa with the degree of B.S. in Electrical Engineering in 1907. In recognition of original investigations carried on at the University, Mr. Edwards was, at the close of his senior year, elected to Sigma Xi. During the summer of 1907 he worked with the Missouri River Power Company at Butte, Mont., and in the fall accepted an appointment as Assistant Instructor at the Massachusetts Institute of Technology. Here Mr. Edwards taught for three years, the last year as instructor in the Electrical Engineering Department. A portion of his leisure hours he devoted to night school classes in Lowell Institute and Wells Memorial Institute.

Mr. Edwards has always manifested a keen interest in research work, and found time while an instructor to conduct several original investigations. Most of this work involved incandescent electric lamps, and the summers of 1908 and 1909, spent in the Engineering Department of the National Lamp Works of General Electric Company at Cleveland, served only to intensify his interest in illumination engineering. In 1910 he accepted a position with the National Lamp Works, where his unusual ability as an investigator and his thorough mastery of the broad subject of electrical engineering have made themselves effective in a general improvement of lighting conditions and in the invention of several unique electrical devices. He is a member of the American Institute of Electrical Engineers (past chairman Cleveland Section), National Electric Light Association (Class E), Illuminating Engineering Society, Society for the Promotion of Engineering Education, Associate Member American Society of Agricultural Engineers, and has served on many boards and committees of societies.

Conservative, yet never hesitating to assume responsibility, quick to detect errors, yet tolerant of the mistakes of others, Mr. Edwards as Electrical Engineer of the National Lamp Works has won the respect and admiration of all associated with him.

WILLIAM C. L. EGLIN

William C. L. Eglin is the Chief Engineer of The Philadelphia Electric Company, and has been identified since 1889 with that company and its predecessors in the electric lighting field in Philadelphia. During this period the smaller electric electric lighting companies were consolidated into one large company, necessitating the standardization of power station equipment and of distribution methods in order that a unified and economic system could be established throughout the city; this work, together with the erection of new ' lants (notably the modern steam turbine station on the Schuylkill River at Christian Street; and a similar plant on the Delaware River at Chester now nearing completion) as needed to furnish capacity for the rapidly expanding business of the company being designed and successfully accomplished under the direct supervision of Mr. Eglin. He is a Past President of the National Electric Light Association; a Fellow of the American Institute of Electrical Engineers and one of its Past Vice-Presidents; a Vice-President of the Engineers' Club of Philadelphia; and a member of the Board of Managers of the Franklin Institute of the State of Pennsylvania. At the International Engineering Congress held in Paris in 1900 Mr. Eglin served as the representative of the Engineers' Club of Philadelphia and the Franklin Institute; and at the International Electrical Congress held in St. Louis in 1904 he presented, by invitation, a paper on Rotary Convertors and Motor-Generator Sets.

He has contributed to the technical press and to various associations a number of engineering papers, practicularly on the steam turbine. He is also serving on the National Commission of physicians and engineers, originally appointed by the American Medical Association, to formulate rules for resuscitation from electrical shock. In addition to his membership in the above-mentioned associations, he is a member of the Engineers' Club of New York; Illuminating Engineering Society; American Electrochemical Society and American Society of Mechanical Engineers. He is a member of the Union League and other prominent clubs of Philadelphia; the Navy League and the National Security League.

HUGO E. EISENMENGER

Hugo E. Eisenmenger, electrical engineer, was born in Vienna, Austria, July 7, 1874. He was graduated from a Vienna college ("gymnasium," eight years classical course) in 1892, from the Technical University ("Technische Hochschule") of Vienna, 1897, and took post-graduate work at Karlsruhe, Germany. After serving for a short time as marine engineer in the transoceanic service of the North German Lloyd, he entered the service of the Siemens & Halske A. G. (afterwards called Siemens-Schuckert-Werke), Vienna, remaining with that company, engaged in design, construction and operation of electrical railroads, until 1907. In 1906-1907 he constructed and later operated the electric lighting plant of the city of Khartoum, Soudan, Africa. In 1908-1909 he was the representative in Japan of the Bergmann Elektrizitaets-Werke of Berlin, with residence in Yokohama and later in Tokyo. Since November, 1909, he has been electrical engineer with the National Electric Lamp Association (now the National Lamp Works of General Electric Co.), Cleveland, Ohio, for which he has traveled extensively in the United States and almost all European countries. Mr. Eisenmenger has published investigations about the theory of Central Station Rates, designed a system of Space Representation of Central Station Rates, etc., has been working for several years in conjunction with the Rate Research Committee of the National Electric Light Association, and has conducted mathematical investigations about the determination of cost of current, influence of diversity factor, characteristics of incandescent lamps, etc. He is a member of the Elektrotechnischer Verein, Berlin; associate member of the American Institute of Electrical Engineers; member National Electric Light Association, and Illuminating Engineering Society, London.

BYRON E. ELDRED

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The average man looks upon the marvelous growth of electricity in the last twenty years as a matter of course. He accepts the comforts and aid its development has brought and gives little thought to the able men who have spent long years in research work to advance the science and harness its power for the world's use. Among those who must be given credit for notable achievement along this and other scientific lines is Byron E. Eldred, who was born in Jackson, Mich., February 12, 1873, the son of Z. C. and Helen (Carter) Eldred. After a thorough preparatory education, he entered Dartmouth College, from which he graduated with the degree of B.S., and was afterwards the recipient of the D.Sc. degree. In 1895, Dr. Eldred opened an engineering office in Toronto, Canada, and since that time has been constantly engaged in the practice of his profession and research work pertaining thereto. He devoted much time to the study of combustion and was awarded the John Scott Legacy and medal by the City of Philadelphia for his able work in this line. He invented a process for control of duration of combustion or temperature and volume of flames, familiarly known as the "Eldred Process." Dr. Eldred is an inventor of achievement and is the head of the Commercial Research Laboratory, specializing particularly in metallurgical and chemical research. He makes no claim to distinction as an electrical engineer, but many of his discoveries have contributed largely to electrical advance, and one of his inventions, in particular, entitles him to have his name enrolled with the notable men who have been pioneers in the electrical field. This is the low expansion leading-in wire for incandescent lamps, displacing platinum. This was invented by Dr. Eldred after leading electricians had failed in similar attempts. This work alone makes him a notable figure in the science and the value of the discovery was duly recognized by the Franklin Institute of Philadelphia, which awarded him the much coveted Elliott Cresson medal, an honor greatly appreciated by inventors all over the world. Dr. Eldred is a member of the Engineers' Club and the Chemists' Club of New York City, the New York Athletic Association, the Authors' Club and the Royal Societies Club of London, England; the National Club of Toronto, Canada; the Royal Society of Arts, and is a Fellow of the North British Academy. Dr. Eldred is president and director of the Commercial Research Company, of 556 Jackson Avenue, Long Island City; the Dutch Liquid Company, Eldred & Palmer Company and Johnson Electric Smelting, Inc. He is vice-president of the Chemical Development Company and the Worcester Evening Post, of Worcester, Mass. He resides in Malba, Long Island.

WILLIAM LE ROY EMMET

In the thirty years of his connection with the electrical profession, during which period he has added many inventions and developments to the resources of electrical engineering, Mr. W. L. R. Emmet has been identified with much important electrical work. He was born in New Rochelle, New York, July 10, 1859, a son of William J. and Julia Colt (Pierson) Emmet. He is a great-grandson of Thomas Addis Emmet, Irish patriot and brother of Robert Emmet. Members of the family have been prominent in the law, science, medicine, and particularly in art.

He was educated in the United States Naval Academy, being graduated with the class of 1881, and served in the Navy as cadet midshipman from graduation until 1883, when he left the service. After various temporary employments he began electrical work with the Sprague Electric Railway and Motor Company in the Fall

of 1887. As a boy he had devoted much time to mechanical constructions of various kinds, and while at the Naval Academy he became interested in science, and particularly in electricity. After serving with the Sprague Electric Company for a considerable time in construction work, he was electrical engineer of the Buffalo Railway Company, and afterward district engineer for the Chicago District of the Edison General Electric Company. Since 1892 he has been continuously engaged in important capacities with the General Electric Company, except for a time in 1898, when he reentered the Navy, serving during the Spanish-American War.

In the electrical field Mr. Emmet was the first to use certain methods of insulation with varnished fabric, which have since had wide application. He developed methods of distribution by alternating currents; actively promoted the introduction of large uses of alternating currents and designed many of the first large installations. He designed many switching and control devices for early large uses of alternating currents, including the first invention and application of oil switches. He directed and promoted the development of the Curtis steam turbine by the General Electric Company, and invented and designed many of its features. He planned and promoted the use of electricity for ship propulsion, invented many features and designed equipment now being applied to many large ships of the United States Navy. He has directed the development of the Alquist system of high-speed gearing now being extensively used in ship propulsion and for other purposes.

He is a fellow of the American Institute of Electrical Engineers; member of the American Society of Mechanical Engineers, Society of Naval Architects and Marine Engineers, Society of Naval Engineers, American Philosophical Society and of the University and Engineers' clubs of New York; Mohawk Club (Schenectady), and Army and Navy Club (Washington). He has been a member of the Naval Consulting Board since 1915.

Mr. Emmet is author of a text-book on "Alternating Current Wiring and Distribution," published in 1894, and has been a constant and extensive contributor to the technical press on many electrical and mechanical subjects. He has always been very deeply interested in literature, natural science, and in history and political science, and in these as well as in subjects connected with the engineering profession he has written many essays and papers.

His researches and inventions in connection with the development of the steam turbine have been continuous since 1900, and have borne an affirmative share in the efficiency and progress of that mode of steam power development and of propulsion.

JUSTUS BULKLEY ENTZ

Justus Bulkley Entz, as electrical engineer and inventor, holds a very prominent place in the electrical profession, with which he has been identified for the past thirty years. He was born in the city of New York, June 16, 1867. His parents were both born in New York and his paternal grandfather came from Switzerland to New York as a young man. His mother's father was a New Yorker, but descended from an old New England family since 1635. He was educated in the schools of the city, and in the College of the City of New York to the end of the sophomore year. He was always interested in electrical matters and attended lectures on the subject by Prof. Doremus, of the College of the City of New York, and by Prof. Chandler, of the College of Physicians and Surgeons. In June, 1887, he entered the Edison Machine Works at Schenectady, N. Y. (the predecessor of the General Electric Company), and advanced in that service until he became chief electrician of the works. He afterwards held the same position with the Waddell-Entz Company; later became chief engineer of the Electric Storage Battery Company; was vice-president in charge of engineering of the Electric Vehicle Company of Hartford, Conn.; electric engineer of the White Company, of Cleveland, Ohio, and is now electric engineer of the Entz-Motor Patent Corporation. Mr. Entz was the inventor and designer of the first multipolar direct-connected dynamos installed in the ships of the White Squadron of the United States Navy, known as

JUSTUS B. ENTZ

Edison marine dynamos. He was the inventor and designer (1889) of the Waddell-Entz dynamos and motors, also of the copper-zinc storage battery known as the Waddell-Entz battery. The Second Avenue Line, in New York, had twelve cars operated by this battery in 1892, and the first electric cars in Vienna, Austria, were run with these batteries in 1894. While chief engineer of the Electric Storage Battery Company, he invented a number of methods for storage battery regulation, including the differential booster, the constant current booster and the carbon regulator. The Encyclopedia Britannica thus characterizes the Entz Booster: "J. B. Entz has introduced an auxiliary device which enables him to use a much more simple booster. The Entz Booster has no series coils and only one shunt coil, the direction and value of excitation being due to this being controlled by a carbon generator having two arms, the resistance of each of which can be varied by pressure due to the magnetizing action of a solenoid. The main current from the generator passes through the solenoid and causes one or other of the two carbon arms to have the less resistance. This change in resistance determines the direction of the exciter field current, and therefore the direction of the boost." He invented the electric transmission now in use in Owen magnetic cars, the first patent for which was filed in March, 1898, and a car built in that year. He also invented the electric starter used by the White Company, Franklin Company and Chalmers Company. He is also inventor of devices in several other fields, having about fifty United States patents. Mr. Entz is a member of the American Institute of Electrical Engineers, the Society of Automotive Engineers, the Engineers Club of New York, the Wykagge Club of New Rochelle and the Huntington Valley Country Club, Noble, Pa.

DUDLEY FARRAND

DUDLEY FARRAND

In a connection with the electric light and power business which has extended over thirty-one years of continuous service, Dudley Farrand has advanced from the position of a novice to the management of one of the country's largest electric corporations. His career during those three decades has been one of constant contact with electrical operations and problems and of intensive study, which has made him a thoroughly equipped electrical and mechanical engineer and one of the ablest and most experienced executives in the electrical field.

He was born on February 21, 1869, in Bloomfield, Essex County, New Jersey, the son of Charles and Anna (Farrand) Farrand. In both paternal and maternal lines he is a scion of the old New Jersey family of Farrand, which settled in that part of New Netherland which later became New Jersey in 1643. The Farrands were French Huguenots, who were driven out of France by religious persecution, going first into England and thence with the English colonists to this country.

Mr. Farrand's early education was in the public schools of Bloomfield, New Jersey, whence, after graduation, he went to Newark Academy, graduating in 1887 and matriculating in the Princeton University class of 1891. He decided, however, not to take the college course, but to accept an offered clerkship with the Newark Electric Light and Power Company. From the beginning of his connection with the electrical business he evinced a deep interest in its operative and technical problems, and devoted to them continuous study, which, combined with practical experience, gave him mastery of the principles and practice of electrical engineering.

Efficiency in his office work secured him promotion in 1889 to the position of Assistant Secretary of the Newark Electric Light and Power Company, and in 1891 he was promoted Assistant Manager, and in 1892 he was put in charge of the Department of Design and Construction.

In 1896 Mr. Farrand was made Assistant Manager of the People's Light and Power Company, and a year later was promoted to General Manager of that company. Subsequent consolidation brought him larger duties and increased prominence as a manager of electrical enterprises. In 1899 he was made General Manager of the United Electric Company of New Jersey, and when by merger of public utility corporations the Public Service Corporation of New Jersey was formed he became, in 1903, the General Manager of the Electric Department of that corporation. In 1910 the Public Service Electric Company was organized to take over the electric properties of the Public Service Corporation of New Jersey and operate them, and Mr. Farrand was selected as General Manager of the company. Early in 1915 he was elected Vice-President and General Manager and remained in that capacity until April 1st, 1917. On that date he was promoted to Assistant to the President of Public Service Corporation of N. J. and like position in each subsidiary operating company, such as Public Service Electric Co., Public Service Gas Co., Public Service Railway Co., etc. It is a large and comprehensive enterprise, covering more than two hundred cities and towns and operating upon the largest scale. The duties of Assistant to the President of the holding Company and of each operating Company call for an exceptional combination of executive ability, practical knowledge and technical skill, all of which Mr. Farrand brings, in full measure, to the performance of his arduous and responsible duties.

Besides conferring upon him an especial fitness for the official position he holds with his own company, the qualifications also endow him with the qualities most valued as a consulting engineer. In that capacity he has given valued service to many large electrical interests all over the country. His exceptional abilities as a consulting engineer received national recognition when President Roosevelt, on appointing the National Conservation Commission, chose him to represent the electrical questions involved as an adviser of the Board of Engineers organized to compile data for the Conservation Commission. He also, upon the invitation of

President Roosevelt, represented the electrical interests in the first Conference of Governors, which convened in the White House in May, 1908.

In connection with electrical interests Mr. Farrand is recognized as a national leader, and he has taken much interest in the work of the National Electric Light Association, of which he was formerly president. It was during his term as President of N. E. L. A. that amendments to the constitution, making possible its present size and importance, were made effective. He is a fellow of the American Institute of Electrical Engineers and a member of the American Society of Mechanical Engineers. He has always taken a deep interest in the rapid developments in electrical service and the corresponding advance in the electrical engineering profession, which has been in continuous progress during the thirty-one years which cover his own connection with electrical interests.

Mr. Farrand is a member of the Essex Club of Newark, New Jersey; the Essex County Country Club of Orange, New Jersey, and the Rumson Country Club of Rumson, New Jersey, and the Engineers' Club of New York. He was formerly a member of the Essex Troop, First Troop of the National Guard of New Jersey, a famous cavalry organization.

DR. COLIN G. FINK

Dr. Colin G. Fink, for the past ten years Research Engineer for the General Electric Company, and who was the first scientist to produce ductile tungsten, is now head of the new Chile Exploration Company's laboratories, where the work is largely research along metallurgical and electrochemical lines. Dr. Fink was born in New Jersey, December 31, 1881, the son of F. W. Fink, of the firm of Lehn & Fink, and graduated from Columbia University with senior honors in 1903. He took special courses in physics, physical chemistry, higher mathematics and mineralogy, and graduated from the University of Leipzig, Saxony in 1907 with the degrees of M.A. and Ph.D. (summa cum laude). He was assistant in Electrochemistry at the Ostwald Laboratory in 1906-7, and upon returning to this country he entered the Research Laboratory of the General Electric Company, at Schenectady, N. Y., under the direction of Dr. Willis R. Whitney, and started on a research in ductile tungsten and molybdenum. The application of electricity to chemistry had fascinated him when a boy and he determined to concentrate on electrochemistry, for this purpose spending four years in the laboratory of Wilhelm Ostwald, who was conceded to be the foremost electrochemist of the world. Dr. Whitney was a student of Ostwald, and this led to Dr. Fink's Schenectady connection. In 1907 Dr. Fink started to solve the problem of ductile tungsten, which the engineers at Schenectady had already tried vainly to do for four years. Similarly, the laboratories at Berlin of Siemens and Halske, of Pintsch, of the Allgemeine Elektrizitaets Gesellschaft and of the Auer Company had already spent large sums in trying to find the secret of ductile tungsten. In Schenectady all but Dr. Whitney were about to give up hope and took comfort in developing methods for pasting the black tungsten powder particles into fine threads. Siemens and Halske put much faith in their tantalum lamp and felt certain that the nickel-tungsten alloy process would become standard throughout the world. The Pintsch people negotiated with Dr. Kuzel and believed that the colloidal process would be the ultimate one, but all these processes produced merely a very fragile thread and no strong tungsten wire. When Dr. Fink took up the problem at Schenectady his associates thought it a joke and took pleasure in playing pranks upon him. On one occasion he had carefully put away in his desk a half-dozen pieces of tungsten rods which he was going to "ductilize" or attempt to do so the following day. Upon examining the pieces in the morning he found they were all soft and ductile. This

DR. COLIN G. FINK

was due to the fact that one of the men had carefully substituted the same size in nickel rods. As Dr. Fink studied through the work that had been carried out at Schenectady and Berlin, he noticed a very striking trait in all tests, whether American or German. The method for testing for ductility consisted merely in bending the sample. If it broke it was brittle, but no mention was made as to the degree of brittleness, or whether one sample was more or less brittle than another. He then began a search for a tool or instrument that would record relative ductility or brittleness. In this search he corresponded with the leading instrument manufacturers, Bureaus of Standards and others, but none could advise. Accordingly, he set out to build an instrument of his own, which delayed his work for about a month. This consisted of a small platinum tube connected at either end to a cur-

rent supply which could be regulated at will. In series with it was a wattmeter. Small samples of tungsten rods, about 15 to 20 thousandths of an inch in diameter, were bent over this tube of platinum, while it was electrically heated to a bright red. The current was then gradually lowered and bend tests made until a temperature was reached at which the rod broke. The watts (or temp.) at this stage were recorded. Then samples of tungsten prepared by a different metallurgical process were tried out, and very soon Dr. Fink obtained indications as to the direction in which he had to work. This ductility instrument was the key to the whole problem, and three months later Dr. Fink had made his first piece of strong, ductile tungsten wire. About one month before obtaining the first ductile wire Dr. Whitney came into Dr. Fink's laboratory and said: "Mr. Rice is telephoning and asking me how soon you will have ductile tungsten. What shall I tell him?" Dr. Fink answered: "Tell Mr. Rice that I shall have the first lot of real ductile tungsten inside of three months!" Dr. Whitney laughed heartily, and Mr. Rice could almost be heard laughing at the other end of the 'phone. Several engineers from the lamp factories came to see Dr. Fink a few months later, and one of them remarked: "It is all very nice, but it will never compete with the paste process." After his success with ductile tungsten Dr. Fink turned his attention to platinum substitutes, and at that time there were between 15 or 20 so-called platinum substitutes on the market. One promoter gave the assurance that he had made up 5 lamps, 3 of which held vacuum. Dr. Fink's predecessors had laid all emphasis on coefficient of expansion and cheapness of materials but ignored the very important factor, the wetting property or cementing force between the glass and the metal. Dr. Fink found that of all the common metals copper makes the best union with lamp glass at lamp-making temperatures. Second to copper was cobalt. Accordingly, he set out to modify the coefficient of expansion of copper or cobalt, and this he did by using a copper tube with a nickel iron core, the coefficient of which compensated that of the tube to bring it down to that of the glass. The wire is now used in *all* countries.

Dr. Fink is a Fellow of the American Association for the Advancement of Science, a Member, Assistant Editor and Past Councillor of the American Chemical Society, President of the American Electrochemical Society, 1917-18; American correspondent for the Bunsen Society, and president of the American-British Club at Leipzig, 1905-07. His publications are:

"Kinetics of Contact Sulphuric Acid," Z. Physikal Chem., 1907; "Ductile Tungsten and Molybdenum," Trans. Am. Electrochem. Soc., 17, 229; "Electric Vacuum Furnace Metallurgy, *ibid.*, 21, 189; "Applications of Ductile Tungsten," Eighth Intern. Congress Appl. Chem., 26, 503; "Electrical Conductivity vs. Chem. Composition," J. Physical Chem., 1917, 32; "Electrolytic Behavior of Tungsten" (with Mr. Koerner), Met. Chem. Eng., XVI, No. 1; "Tungsten" Mineral Industry, 1913, 1914, 1915, 1916; "Scientific Meetings in War-Times," Science, 45, 661, etc., etc.

His address is 202d Street and 10th Avenue, New York City.

FREDERICK P. FISH

FREDERICK PERRY FISH

The men who have been the creators and promoters of the wonderful advance of electrical industries which has astonished the world are of many talents. The pure scientists who have wrested from Nature's breast the secrets of electrical power, the engineers who have put them into tangible form and applied them to useful ends, the organizers, lawyers and capitalists who have brought to the development of electrical industries through great corporate organizations the sobering and coordinating elements that have made present progress possible—all these have been necessary factors in the creation of the Electric Age in which we live.

One whose participation in this progress has been especially active and influential is Frederick Perry Fish, a member of the Boston Bar, who has been professionally and personally prominent in many of the larger and more important electrical industries, but especially in the building up of the great Bell Telephone system and its dependent and associated enterprises and corporations, of which he was long the executive head.

Mr. Fish was born in Taunton, Mass., January 13, 1855, the son of Frederick L. and Mary Jarvis (Perry) Fish. He was graduated from Harvard A.B. 1875, and attended the Harvard Law School, 1875-1876; was admitted to the bar and engaged in the practice of law in New York and Boston until July 1, 1901.

He had early become associated, professionally and personally, with various electrical interests, and particularly with the development and application of the telephone to the needs of the life and industry of the country. He became interested in the Bell Telephone in the early stages of its commercial development, when many of its basic interests were involved in difficulties and litigation, and he was one of the first to foresee and plan the methods to meet the possibilities of telephone expansion, and to organize the companies and enterprises necessary for extension of telephone service to all parts of the country. Local and long-distance companies for service and a larger general organization for coordinated control and improvement of the telephone business were organized, largely by his initiative and direction, creating for this country the best and most comprehensive telephone system in the world and making the telephone a far more intimate factor in life and industry here than in any other part of the world. He discontinued the practice of law in 1901 in order to devote his attention entirely to the large telephone interests of which he became the organizing and executive head. He was president of the American Bell Telephone Company, American Telephone and Telegraph Company, Western Telephone and Telegraph Company; also director of the New England Telephone and Telegraph Company, the New York and New Jersey Telephone Company, New York Telephone Company, Pennsylvania Telephone Company, Southern Bell Telephone and Telegraph Company, General Electric Company and Western Electric Company. Under his direction there was a great expansion of the business and a thorough organization of its operations effected, and the American Telephone and Telegraph Company, under which the various subsidiary and associate companies were harmonized in coordinated policies and practices, was built up to a position of unquestioned leadership among the world's foremost telephone organizations. Having accomplished this, he resigned the executive office and duties into other hands and returned to the practice of law in Boston on May 1, 1907, in which he still continues.

Mr. Fish has always taken a deep interest in educational affairs, is a loyal son of Harvard and a member of the Board of Overseers of Harvard University, a member of the Corporation and Executive Committee of the Massachusetts Institute of Technology, associate and member of the Council of Radcliffe College, and is Chairman of the State Board of Education of Massachusetts. He is a director of the New England Trust Company and of the Old Colony Trust Company. He remains deeply interested in electrical affairs, in which he was long an important and con-

structive factor. He is an associate member of the American Institute of Electrical Engineers; and he has a familiar knowledge of the legal questions and administrative problems connected not only with telephony but also with other branches of the electrical industry.

Mr. Fish is a member of the Union, St. Botolph, University and Exchange Clubs, of Boston, and the Union, University, Grolier, National Arts, Railroad, and Harvard Clubs, of New York.

HENRY WRIGHT FISHER

Henry W. Fisher, chief engineer and manager of the Lead Cable and Rubber Works of the Standard Underground Cable Company, of Perth Amboy, N. J., was born in Youghal, Ireland, January 31, 1861, the son of Abram and Sarah (Wright) Fisher. He came to America in 1874 and fourteen years later received the M.E. degree from Cornell University. After graduation he was connected with Bergman & Co., and the C. & C. Motor Company and then entered the service of the Standard Underground Cable Company, becoming its chief engineer in November, 1889. He devoted part of his time to developing the testing department of the Central District & Printing Telegraph Company, Pittsburgh from 1891 until 1893, and was later superintendent of the Pittsburgh factory of the Standard Underground Cable Co. Mr. Fisher is a member of the American Institute of Electrical Engineers, the Engineers' Society of Western Pennsylvania, of which he was president in 1901-2, the American Electrochemical Society, American Society for Testing Material, Sigma Xi Fraternity, University Club of Pittsburgh, the Chemist Club and the Cornell University Club of New York and is ex-president of the Esperanto Association of North America. Mr. Fisher has devoted much time to research and investigation and has originated methods of locating faults in cables, etc. He has prepared many papers as the result of this work which he has read before electrical bodies and contributed to the technical press.

ALAN E. FLOWERS

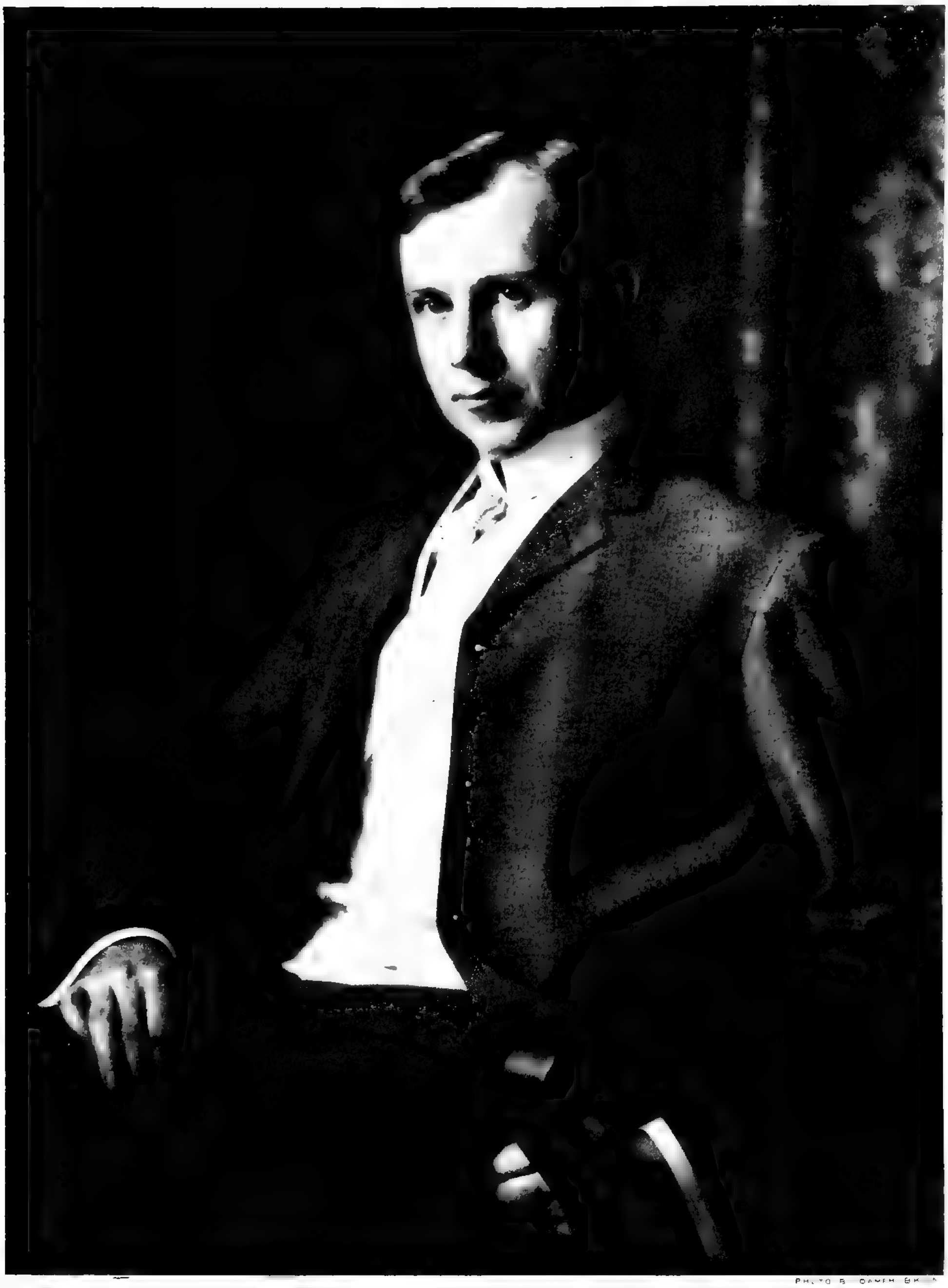
Professor Alan E. Flowers has combined in his career important contributions to electrical science, valuable work in professional practice, and distinction as professor of electrical engineering. Born in St. Louis, Missouri, October 4, 1876, he was graduated from Cornell as M. E., 1902, M. M. E., 1914, and Ph. D. 1915, and received election to Sigma Xi, as well as to the University scholarship on graduation. He was identified with the important college sports, making the Class Track Team, and the 'Varsity Four-Oared Crew as stroke.

He began his professional work as an engineer's helper with the Westinghouse Electric and Manufacturing Company, with which he was an apprentice, in 1901 in their construction district in and near Philadelphia. His first piece of work was grinding-in the carbon brushes of a small direct current generator. He advanced steadily in the profession, has been engaged as engineer with the Bullock Electric Manufacturing Company, the Telluride Power Company, the Bear River Power Company, and as investigator with the General Electric Company, in its Consulting Engineering Department in the Protective Apparatus Laboratory. He is now appraisal engineer for the Columbus Railway, Power and Light Company, of Columbus, Ohio.

He began his collegiate instruction work with the University of Missouri, in which he was successively instructor, assistant professor and associate professor, and then accepted the position of professor of electrical engineering in the University of Ohio, which chair he now holds.

His chief interests outside of his profession center in the study of economics, psychology and sociology, and in music.

He is a member of Sigma Xi, Tau Beta Pi, Lambda Phi, Phi Mu Alpha, the American Institute of Electrical Engineers, American Society of Mechanical Engineers, American Society for Testing Materials, American Physical Society, American Electrochemical Society, and others both of professional and social character.



W. WINANS FREEMAN

W. WINANS FREEMAN

The rise of W. Winans Freeman from the position of stenographer to that of executive head of public utility corporations, is a story most worthy of incorporation in a history of the development of the electrical industry. Mr. Freeman was born in Exeter, Ontario, Canada, June 8, 1872, the son of Asakel Davis and Louisa Ann (Winans) Freeman. The father was descended from the Black family, who were pioneer settlers in Nova Scotia, and the mother was of English descent, one of her ancestors being an officer in the army of Lord Cornwallis, while another, William Carson, was the builder of the first frame house in Prince Edward County, Canada. Mr. Freeman's education was obtained in grammar and high schools of Listowel, Ontario, and after graduation he entered the employ of Hess Brothers, a local furniture manufacturing concern. He severed his connection with this firm in order to come to the United States, and in 1889 he became a stenographer in the office of the general manager of the Edison Electric Illuminating Company of Brooklyn. His aptitude and energy in this position were of such a character that he was soon made private secretary to the general manager. From that time his advancement was steady, successively becoming assistant secretary, secretary, treasurer, and finally, vice-president and general manager of the company. The latter position made him the active head of the concern, as the office of president was an honorary one, without active duties, and it also involved similar official titles and duties in the organization's allied companies. While in this position Mr. Freeman became interested in a number of outside enterprises, but on January 1, 1913, severed all his Brooklyn affiliations to accept the position of American representative of Sperling & Co., London, England. The house of Sperling & Co. is one of the most powerful in the English capital, and has large investments in public utilities in the United States, Canada and Mexico. Among the firm's holdings are the Alabama Traction, Light & Power Co., Alabama Interstate Power Co., and the Alabama Power Co., of which organizations Mr. Freeman was vice-president and general manager. In 1914 he became associated with the Columbia Gas & Electric Co., with headquarters at Cincinnati, Ohio. With this position he assumed executive direction of the company's various utility properties. He is now president of the Union Gas & Electric Co., Cincinnati, Ohio; Union Light, Heat & Power Co., Covington, Ky., Cincinnati, Newport & Covington Railway Co., Covington, Ky.; South Covington & Cincinnati Street Railway Co., Covington, Ky., and numerous smaller subsidiary companies. Mr. Freeman is a member of the American Institute of Electrical Engineers, Illuminating Engineering Society, New York Electrical Society, Manufacturers' Association of New York, the Brooklyn League and the Canadian Society of New York. He is a director of the Electrical Show, Inc., and is past president of the Association of Edison Illuminating Companies and the National Electric Light Association, also serving as chairman of the Public Policy Committee of the last named organization for the past three years. His clubs include the Lawyers, Engineers' and Lotos, of New York City, the Beauvoir and County Clubs of Montgomery, Alabama, and the Queen City, Country, Business Men's and Cincinnati Golf Clubs, of Cincinnati, Ohio.

Mr. Freeman was married in 1895 to Ellen Burrows, daughter of the late Chester D. Burrows, and a leader in the social and club life of Brooklyn. Of this union there are three children—a daughter and two sons. Mr. Freeman's offices are at the corner of Fourth and Plum streets, Cincinnati, Ohio, and he resides at the Cincinnati Country Club.

FRANCIS A. J. FITZ GERALD

As a man of science and a chemist and electrical engineer of notable ability and valuable achievement, Mr. Francis A. J. Fitz Gerald is well and widely known in the electrical world. He has been associated with some of the most important developments of electro-chemistry and in the evolution of the electric furnace as one of the most important factors in such developments.

He was born June 1, 1870, in Dublin, Ireland, in which city he was educated and grew to manhood. He entered Trinity College, Dublin University, and was graduated from that famous institution in the Class of 1891, being honorman, silver medallist and junior moderator in experimental physics and chemistry. He came to the United States in 1893 and entered the Massachusetts Institute of Technology, whence he was graduated in 1895, having taken the complete courses in electrical engineering in that institute. He was always an eager investigator in the realm of technology, and after his graduation at Boston he secured from his old friend, the late William M. Laffan, of the New York Sun, an introduction to Nikola Tesla, who strongly advised him to try and secure employment with Dr. Edward G. Acheson in his interesting electric furnace work. Following this advice he went to Niagara Falls and was engaged by Dr. Acheson as assistant in the Carborundum Company's works there, and in that connection was active as aid to the experimental work of Dr. Acheson in developing his electric furnace process for production of graphite and graphitized electrodes evolved in the Niagara Works. He became chemist of the Carborundum Company in charge of furnaces, etc., and afterward was with the Acheson Graphite Company as chemist. In these connections he became an expert of

great skill in electric furnace operation and the application of the electric furnace to chemical and metallurgical uses.

He thereupon concluded to embark for himself as a consulting engineer, in which capacity he is now president of the Fitz Gerald Laboratories, Inc., of Niagara Falls, New York, and has at various times acted as consulting engineer for the General Electric Company, the National Carbon Company, Norton Company, the Titanium Alloy Manufacturing Company, as well as others, and renders efficient service in many chemical and electrical capacities, and especially in connection with electric furnace problems, to which, in addition to his study and practical experience in the Acheson enterprises, he has devoted much patient and successful experiment. He is thus fully equipped for the highest types of expert work in connection with designing, installing and directing the operations of electric furnaces.

Mr. Fitz Gerald is a member of the American Institute of Electrical Engineers, of the American Electro-chemical Society (of which he is past president), the Franklin Institute of Philadelphia, the Faraday Society, the American Association for the Advancement of Science, the Niagara Club, Engineers' Club of New York, and the Technology Club of New York. He has completely equipped laboratories for working out problems and tests along certain electro-chemical lines, and especially the carrying out of experiments involving the use of electric furnaces.

While largely absorbed in original research in electricity and chemistry, Mr. Fitz Gerald finds time for gardening, which is his outdoor recreation, and for music.

JOSEPH C. FORSYTH

Joseph C. Forsyth, who has been chief inspector of the New York Board of Underwriters for twenty-seven years, brought to that position when appointed a thorough knowledge of electrical matters gained, technically, by a college course and practically with some of the leading electrical organizations in the city. He was born in Logan County, Ohio, November 4, 1861, and was educated at the Ohio Normal University and the Johns Hopkins University, Baltimore, Maryland. He began his business career in Boston, Mass., in 1888, and one year later came to New York City and became associated with the Edison Electric Illuminating Company of New York. He was also connected with the United Electric Light and Power Company of New York. He was

JOSEPH C. FORSYTH

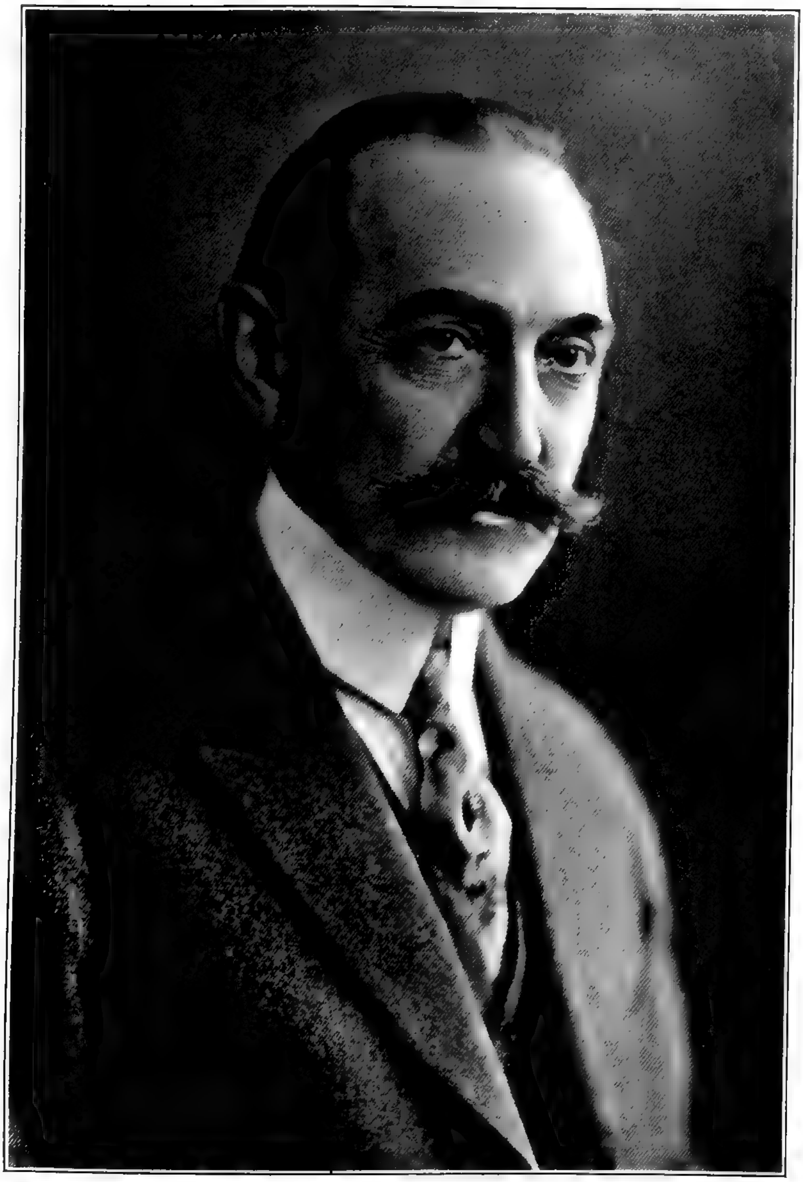
employed in the construction departments of these live organizations, and his equipment was thorough to assume the duties of chief inspector of the New York Board of Fire Underwriters, when he was appointed to that position April 1, 1891. This is proven by his retention of the office for twenty-seven years, during which time he has collected and preserved many original electrical papers and a vast amount of data relative to the work of the Board. Mr. Forsyth is a member of the American Institute of Electrical Engineers and the New York Electrical Society. His offices are located at 123 William Street, and he resides at 406 Jefferson Avenue, Brooklyn, N. Y.

NELSON W. GAGE

Nelson W. Gage was born on a farm in Albany County, New York, September 10, 1865. At the age of 16, after a common school education, he secured an appointment as teacher in a public school at Knox, N. Y., in his home county. With an ambition to go through Union College, he later took up a preparatory course at Classical Institute, Schenectady, N. Y. Lack of sufficient funds, however, forced him to abandon this idea and take a position in a factory in Troy, N. Y. After four years there, the obvious limitations of his position caused him to buy a boat ticket for New York City and brought about an association with J. Fred Wagner, then publisher of Western Stationer and Western Paper Trade. One year and a half later a new publishing connection was made, that of advertising representative on the Electrical World. At that time W. J. Johnson was owner of the Electrical World, with C. E. Stump, manager; W. T. Hunt, advertising manager, and Dr. Louis Bell, editor. In a way that is characteristic of his analysis of all matters, Mr. Gage, upon becoming acquainted with all branches of the electrical trade, was soon convinced that the service rendered to readers and advertisers through the existing engineering journals was most incomplete, and their real value only roughly known by the publishers. The *elimination of waste circulation* and how to develop a service to buyers carrying with it a complete advertising service to manufacturers that could be closely estimated, became and has ever since been his hobby. Finally, with a definite plan formulated, Mr. Gage organized the Buyers' Reference Company, in the fall of 1892, and established an office at 114 Nassau Street, New York City. He planned through this organization to create companion publications for buyers made up in such a way that each would give in convenient reference form all the information necessary to intelligently locate and buy electrical apparatus in any particular field. Through this plan an advertising service was therefore offered manufacturers and distributors who desired to reach one or more branches of the electrical industry on a basis that eliminated waste circulation of other existing mediums. The Buyers' Reference was therefore published in three editions, one devoted to the electric light and power field, another to the street railways, a third to electrical contractors and dealers. Each was published quarterly and contained a classified list of electrical goods, with the names of the makers. Associated with advertising in these publications was an auxiliary service in the form of separate and distinct lists of buyers in the fields covered by each publication. This publishing idea furnished a new advertising service which, as it was worked out, not only eliminated waste circulation, but made it possible for an advertiser to go direct to the buyers in any particular field.

The scheme, although successful at once, developed limitations from a publishing standpoint on account of the expense of distribution by third class mail postage, which became more and more evident as the various branches of the electrical industry expanded by leaps and bounds and the various sections of it began to overlap to a marked degree. A solution was worked out in 1907, however, through the combination of the overlapping editions of the Buyers' Reference into a business and nontechnical publication. The combination was developed along the lines of the stronger edition of the Buyers' Reference under the name Electrical Record, and the corporate name of the publisher changed to The Gage Publishing Company, Inc. To this publication, which possessed all the features of the classified list of manufacturers of the Buyers' Reference, was added an editorial section, a new feature of the plan which has since made it possible to complete a service to electrical buyers of the broadest character along practical and useful lines.

It is of interest to note that at the time of the organization by Mr. Gage of the Buyers' Reference Company there were six publications devoted to the electrical industry, three of which have survived and absorbed two of the others. The six publications referred to are the Electrical



NELSON W. GAGE

World, Electrical Engineer, Electric Power, Western Electrician, Electrical Review, and the Street Railway Journal (now the Electric Railway Journal). As an indication of the state of the industry twenty-five years ago, it is only necessary to mention that the Street Railway Journal carried advertising of horse and mule shoes, harnesses, hames and collars, while advertising solicitors on the Electrical World called on manufacturers of street cars and securing as much or more business from steam engine and boiler makers as from manufacturers of electrical equipment. At that time there were prehaps 300 manufacturers of electrical apparatus. The leading jobbers of electrical supplies included, E. S. Greeley & Co., J. H. Bunnell & Co., W. R. Ostrander & Co., and Alexander, Barney & Chapin, New York City; Partrick and Carter Co. (later known as Partrick, Carter and Wilkins), and Novelty Electric Co., Philadelphia, Pa.; Boston Electric Company and Pettingell-Andrews Co., Boston, Mass.; the Ansonia Electric Company, Chicago, Ill., which handled the output of the Ansonia Electric Company of Ansonia, Conn., Western Electric Company and the Great Western Electric Supply Company, also in Chicago. Today there are approximately 5,000 electrical manufacturers and 270 jobbers, 23 of these being in New York City alone.

On account of a love for outdoor life, Mr. Gage in 1908 purchased a country home in Schenectady County, New York, near his birthplace, where he devotes a part of his time to the raising of registered Holstein cattle and the exercising of thoroughbred Kentucky saddle horses. In the very neighborhood of his present country home, his grandparents of English descent settled, and nearby also his father and mother were born. A bit of family history is that the acquaintance of his parents' families was brought about by the echo of axes while chopping wood in adjoining forests one cold winter morning.

Mr. Gage is a member of the New York Athletic Club and a pioneer member of the Aeronautic Society. He joined the Seventh Regiment during the Spanish-American War and re-enlisted in May, 1917, being now a member of the Seventh Regiment of Infantry, New York Guard.

GUION M. GEST

Underground conduit construction and the name of G. M. Gest have been linked together for the past quarter century. The first work of this nature started by Mr. Gest was in Cincinnati, and since then he has been identified with underground installations in all of the large cities of this country and Canada.

A great many improvements in construction methods owe their origination to him and it has been the use of these methods coupled with the speed of installation that has helped to make the success of his business. His main offices are in the Woolworth Building, in New York City and in the Power Building in Montreal, with branch offices in Cincinnati, San Francisco and Vancouver.

In order to encourage interest in underground work, Mr. Gest has always been a large exhibitor at the expositions, the last one being the Pan-American where he was awarded the gold medal. His exhibit in the Palace of Machinery showing all types of underground conduit and cable installation attracted a widespread interest. At the St. Louis Exposition he was given the highest award.

He has also been represented at all the conventions of the National Electric Light, and Street Railway Associations, and many will recall the manholes in Cincinnati and Montreal which he had fitted up for the entertainment and reception of the delegates.

Over two hundred cities have been benefited by the installation of underground systems by this organization, and they have installed 1,000,000 duct feet or over in each of the following cities: Chicago, Brooklyn, Montreal, New Orleans, Winnipeg, Reading, Toronto, Hartford, Dayton, Cincinnati, Nashville and the City of Mexico.

In addition to other installations in which they are engaged, that which stands out preeminently at the present time is the ornamental lighting system of the entire city of New Orleans. This is the largest single contract of its kind ever awarded. Many companies have called upon them to execute a second and often more contracts, while in some cases they do all the underground work.

ELWOOD GRISSINGER

The subject of this sketch was born on a farm near Mechanicsburg, Pa., in the beautiful Cumberland Valley, on March 3rd, 1869, the eldest son of Theodore and Sybilla Grissinger. Theodore Grissinger was a student of affairs, a deep thinker, a man of natural engineering ability, and was possessed of inventive talents above the average. About 1879 the family removed to Mechanicsburg, Pa., where Elwood Grissinger entered the public schools. He graduated from the High School in 1885 with a rating of 100. During his vacations, he was always engaged in shops or factories, wherever there was something of interest and something to learn.

Of his ancestry, it is recorded in the "History of York County, Pa.," that his paternal ancestor, John Grissinger, came to this country prior to the Revolutionary War and settled at Lewisberry, York County, Pa. John Grissinger was born in Germany. The history of the family records that he served in the Revolutionary War without pay, followed farming, died at the age of ninety-eight years, leaving a farm to each of his thirteen children. He is buried in St. John's Cemetery, near Lewisberry, Pa., and at the time of his death had 382 direct descendants.

Within a few months after Elwood Grissinger graduated from the High School, the father wished the son to enter West Point or Annapolis, and, if neither was possible, then to pursue studies in medicine, with special reference to surgery, in some university. None of these suggestions availing, the son was invited to choose his own college, university or profession, but, above all, to begin something. He declined to make a beginning along the lines of a professional education, for the sole reason that he did not know what course of study he wished to pursue. Accordingly, the father told him that he could not remain around home doing nothing; and, by mutual consent, the son entered the ticket office of the Cumberland Valley Railroad Company at Mechanicsburg, Pa., where for some months, without compensation of any sort, he applied himself toward learning something of the details of the railroad business and of telegraphy in particular. His great interest in electrical matters undoubtedly began with the study of telegraphy, although he well remembers the year of the Philadelphia Centennial and seeing the earliest pictures of the first electric lighting from the Edison system in New York as pictured and portrayed in the Scientific American at the time. The pictures and descriptions of inventions and technical matters always evoked a lively interest in him.

At the age of 17 he struck out to support himself, and accordingly he is found on the day trick as a railroad operator at what was then known as Liberty, Va., half way between Lynchburg and Roanoke on the Norfolk & Western Railroad. He remained with that company for about one year at a salary of $35 per month, and while there began the study of stenography. In 1887 he spent three or four months at Oswego, N. Y., in a business school, teaching penmanship and completing a course in stenography and typewriting. From this school he entered the employ of the New York, Ontario & Western Railroad Company, in the General Passenger Department, on Exchange Place, in New York City. From the office of this company he accepted a position with the Pennsylvania Railroad Company, at Harrisburg, Pa.

Under the advice of his superior at Harrisburg, Mr. William J. Rose, Division Freight Agent, and while there was yet time, he left the employ of the Pennsylvania Railroad and after six months' preparation was admitted to the Lehigh University, at South Bethlehem, Pa., in September, 1890, from which university

ELWOOD GRISSINGER

he was graduated with honors in June, 1894, receiving the degree of Electrical Engineer.

While a student of the University, he was active in class and college affairs, having been on the editorial staff of class and college publications. Among his other activities, he was one of the founders and a president of the college supply bureau, president of the Electrical Engineering Society, each year a class officer, a member of the committee seeking to improve the course of Electrical Engineering at the University, a member of the Junior Reception Committee to the graduating class of 1893, a member of the class day committee for the graduation of his class, a member of the Delta Upsilon Fraternity and a commencement orator.

Shortly after graduation he determined that the most promising field of endeavor lay in the long-distance transmission of power, and through the good offices of the officials of the Pennsylvania Railroad Company he entered the employ of the Westinghouse Electric & Manufacturing Company at Pittsburgh, Pa., in August, 1894. In March, 1896, he was designated District Engineer and Salesman of the Westinghouse Company at Syracuse, N. Y., selling one of the first large equipments in the State of New York for hydro-electric power, that of the Dolgeville Electric Light & Power Company at Dolgeville, N. Y. In 1898 he was transferred in the same capacity to Buffalo, N. Y., and in May, 1899, the late W. B. Rankine induced him to accept a position as Commercial Engineer of the Cataract Power & Conduit Company at Buffalo, N. Y. In that capacity he served the interests of the Niagara Falls Power Company until March, 1906, when he became General Agent of the Niagara Falls Power Company and the Canadian Niagara Power Company. With the exception of the electro-chemical industries at Niagara Falls, the trolley systems and general lighting, the rapid growth of the business of the Niagara Falls Power Company between 1899 and 1906 was entirely due to the efforts of Mr. Grissinger, who had sold for installations of relatively small size an aggregate of about 50,000 H.P., the requirements of each of the original customers having since that time been considerably increased. Mr. Grissinger possesses the uncommon qualifications of engineering ability and commercial training of a high order. For some years he was a regular contributor to the Journal of the Brotherhood of Locomotive Engineers and the Locomotive Firemen and Enginemen's Magazine on practical electrical subjects as related to electrical railroading in particular. Since April, 1907, he has followed his profession as a Consulting Engineer.

In October, 1897, Mr. Grissinger married Lucy M., the eldest daughter of the late Isaac Ash of Oil City, Pennsylvania, for fifty years one of the most prominent attorneys-at-law in Venango County, Pennsylvania. Mrs. Grissinger is a direct descendant of John Philip Bahl, an officer in the Continental Army of the Revolutionary War and of Dr. Detwiller, who introduced Homeopathy into this country. They have one son.

In the spring of 1899 he was attracted by editorial and other comment in the columns of the Electrical World to articles bearing upon the value of a commercial telephone repeater or relay, analogous to the telegraph repeater. Having endeavored to follow telephonic development more or less closely (his graduation thesis from the university had to do with telephone transmitters), he resolved to begin anew his experiments in the telephonic field. From that time, in connection with any and all other work, he never abandoned for a moment what he then began, but worked long into the night, night after night, as only inventors know, developing the first commercial talking telephone repeater or relay employing a vibratory element and the first and only practical, reciprocally talking telephonic circuit into which a telephone repeater is to be connected so that a standard two-wire circuit can be reciprocally operative without the intervention of manually or otherwise controlled switches or equivalent apparatus.

Since the invention of the telephone itself, it is unquestioned that Mr. Grissinger's inventions constitute one of the greatest and most important steps forward as affecting telephonic transmission over distances.

The first demonstration of his repeaters and circuits was given at an independent telephone convention held in the Sherman House, Chicago, Ill., in February, 1912. The first demonstration of his invention on commercial lines was given in Chicago, Ill., in January, 1913, and a description of his work in this connection is noted in an issue of Telephony, dated February 15th, 1913, while the American Telephone & Telegraph Company were furnished with instruments for observation and test in July and August, 1913. The first transcontinental talk was advertised in January, 1915.

While he began to develop the telephone repeater primarily, his researches carried him over the entire field of sound waves, sound wave transformation and sound wave propagation, with the result that today he is regarded as a leading authority on these subjects. He was forced to study the telephone transmitter, the telephone line and intermediate apparatus. In doing so he has been able to satisfy himself that long-distance transmission of telephonic voice currents as we have come to look upon it is dependent only upon successful telephone repeaters or relays as apparatus in the line. While it is his opinion that loading coils will always have a field of application and represent a meritorious and brilliant invention and development, yet, with properly designed telephone repeaters suitably installed loading coils are no longer essential for long-distance transmission. He satisfied himself and others on this point as long ago as 1912, when, with five repeaters of his own design, he was able to converse easily, without impairment of quality, over practically non-inductive artificial telephone cable equivalent to 4,500 miles of standard telephone line as represented by the character of line at present used across the continent. It is his opinion that long-distance telephone transmission is only limited by the commercial requirements of the case.

In June, 1916, Mr. Grissinger received the earned degree of Master of Science from Lehigh University in recognition of his researches and development work in the science and art of Telephony, and in the same month of the same year the American Telephone & Telegraph Company purchased the rights to his inventions of the telephone repeater and circuits for the United States of America.

PHILIP G. GOSSLER

PHILIP G. GOSSLER

Philip G. Gossler, whose work as an engineer has made him well known throughout the United States and Canada, and who now acts in an advisory capacity in engineering matters and is a member of the banking house of A. B. Leach & Co., was born in Columbia, Pa., August 6, 1870, the son of Philip and Emily (Washabaugh) Gossler. After a preparatory education in the schools of Columbia, he entered the Pennsylvania State College, graduating in 1890 with the B.S. degree. He afterwards took an engineering course and was awarded the degree of electrical engineer in 1892. His first positions, after completing his education, were in the engineering department of the Chester Foundry and Machine Co., Chester, Pa., and the Edison General Electric Co. of New York, afterwards becoming assistant engineer of the United Electric Light and Power Company of New York, remaining with this corporation until 1895, and during the interim engaging in post-graduate work at the School of Mines, Columbia University.

From 1895 until 1904, he was located in Montreal, Canada, as general superintendent of the Royal Electric Company, and later after the consolidation of the local companies was made general superintendent and engineer of the Montreal Light, Heat and Power Company, remaining in that capacity until 1904. During this period the service was greatly expanded and extended, favorably comparable to any system in the world.

Mr. Gossler returned to New York in 1904 as vice-president of J. G. White & Co., with which he is still affiliated as a director, and in 1909 he formed his present connection, as vice-president and director, with the firm of A. B. Leach & Co., Inc., which, in addition to being one of the leading banking houses in the country, is largely interested in public utilities throughout the United States.

Besides his connection with A. B. Leach & Co., Inc., Mr. Gossler is identified with many public utility companies. He is chairman of the board of directors of the Columbia Gas and Electric Co. and the Union Gas and Electric Co. of Cincinnati, Ohio. He fills the position of president and director of the Helena Light, Heat & Power Co., Eastern Pennsylvania Railway Co., Dominion Power Co. of Virginia, Dominion Power Co. of West Virginia, Long Acre Electric Light & Power Co., New River Power Co., South Carolina Light, Power and Railways, Virginia Power Co., of Charleston, W. Va., and the West Virginia Power Co.

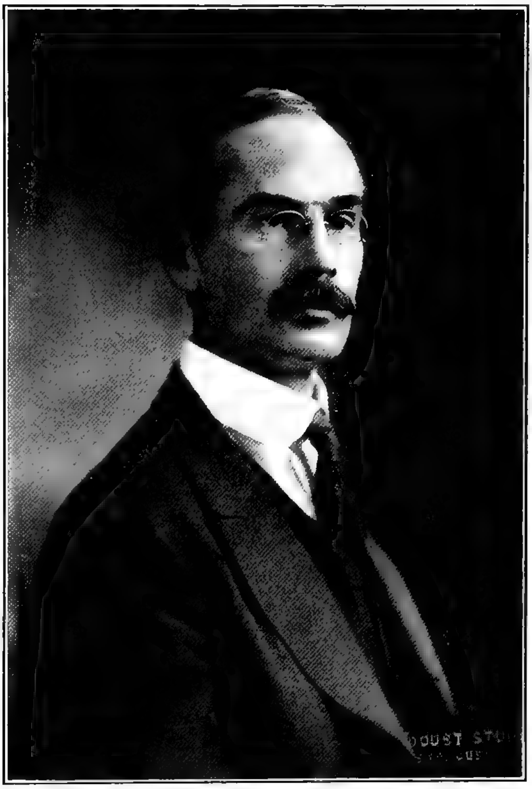
The companies of which he is vice-president are Cumberland County Power & Light Co. of Portland, Me., the Central Georgia Light & Power Co., Central Georgia Transportation Co., Macon Gas Co., Macon & Atlanta Construction Co., the United Fuel Gas Co.

He is a director of J. G. White & Co., New York City, Central Sugar Corporation, Newport & Covington Railway Co., Portland Electric Co., South Covington & Cincinnati Railway Co., Eastern Pennsylvania Railways Co. and the Union Light, Heat & Power Co.

Mr. Gossler is a member of the American Institute of Electrical Engineers, National Electric Light Association, Engineering Institute of Canada, Canadian Electrical Association (past president), New York Electrical Society (past vice-president), Pennsylvania Society of New York, Pilgrims' Society of America, Metropolitan Club, Lawyers' Club, Engineers' Club, Bankers' Club of America, Explorers' Club, New Canaan Country Club, Greenwich Country Club, New Canaan Association, Stamford Riding & Driving Club, Woodway Country Club, Ox Ridge Hunt Club of Connecticut, St. James Club, Montreal, and the Franklin Institute of Philadelphia. He was married in Brooklyn, N. Y., November 26, 1895, to Mary Claflin, and they have three children, Mary, Katherine and Philip. His office address is 62 Cedar street, New York City, and he resides at 152 East 63rd street, New York City; country house, High Field, New Canaan, Connecticut.

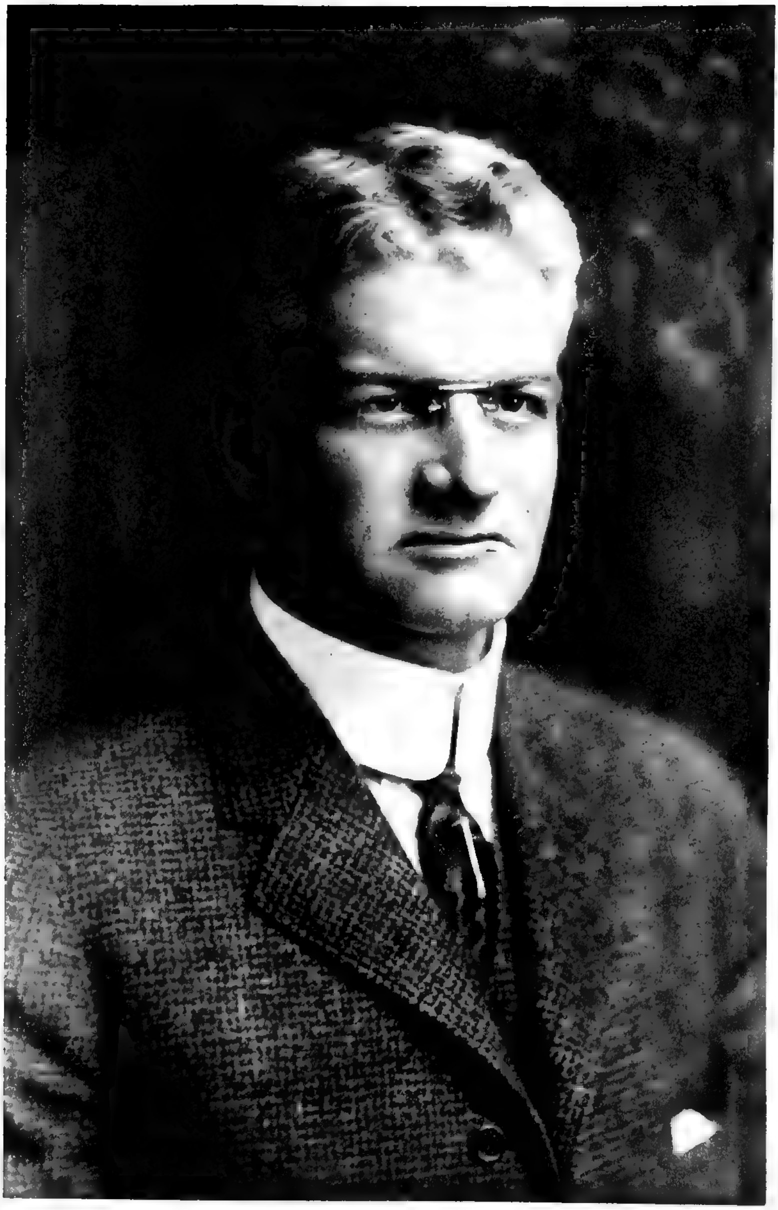
WILLIAM PRATT GRAHAM

With the greater developments of electricity as a factor in life and industry, the need for specially trained engineers has been impressed upon our Institutions of higher learning, whose facilities have therefore been exercised in increasing volume and efficiency toward supplying technical education. Among those who



WILLIAM PRATT GRAHAM

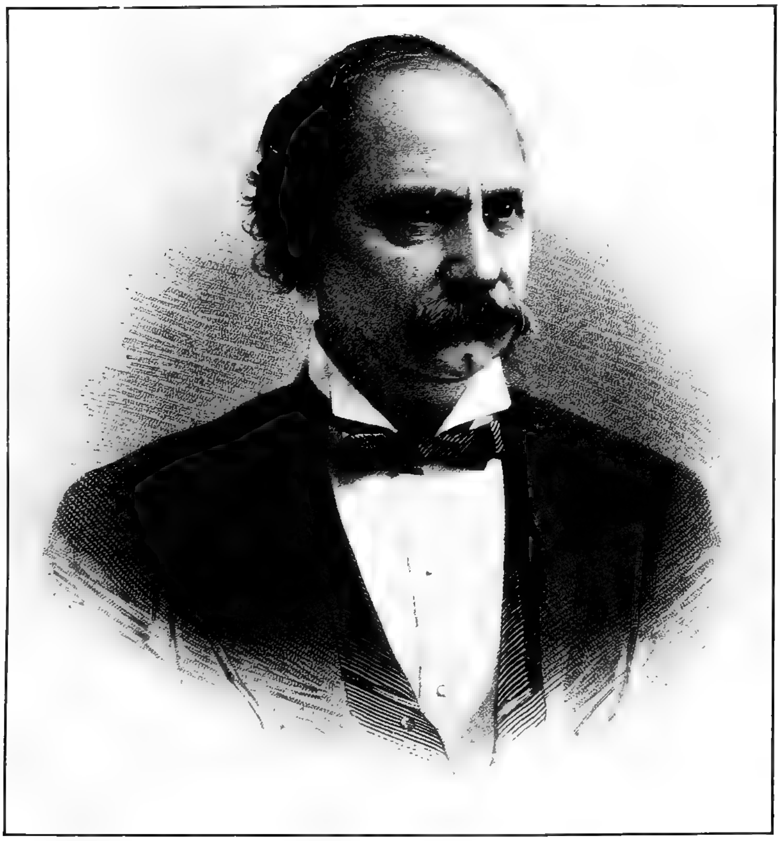
have been active in this development is Dean William Pratt Graham, of the College of Applied Science in Syracuse University. He was born in Oswego, New York, November 24, 1871, his father being a veteran of the Civil War, and his ancestors of the War of 1812 and of the Revolution. He was graduated from Syracuse University, B.S., in 1893. Having a natural inclination toward the study of pure and applied physics, and noting the growing demand for men trained as electrical engineers he determined to specialize in physics, mathematics and electrical engineering at the University of Berlin, from which he was graduated Ph.D. in 1897, and took special courses in the Technische Hochschule at Darmstadt. He joined the Beta Theta Pi fraternity at Syracuse and has been elected to the honor societies of Phi Beta Kappa, Sigma Xi and Tau Beta Pi. He joined the Faculty of Syracuse University in 1898 as associate professor of Electrical Engineering and did construction work in creating effective courses in that study. In 1901 he was promoted professor of electrical engineering and entrusted with the organization of the separate department of Electrical Engineering, which he has developed to a prominent place among American technical colleges, offering complete courses of study and laboratory work leading to the degree of electrical engineering. His work in the development of this Department, evincing not only sound scholarship and pedagogical ability but also executive faculties of high quality, led to his selection in 1911 for the office of Dean of the College of Applied Science in Syracuse University, which he has ever since administered, with a steady advance in membership and prestige of that college. During the years from 1899 to 1907, Professor Graham was connected with the Straight Line Engine Company, an important manufacturing enterprise of Syracuse, as director. Outside of his regular professional work, Professor Graham takes much interest in physical astronomy, and with E. D. Roe, Jr., he worked out a new theory of comets. In 1896 and 1897 he made a special study of the phenomena accompanying the passage of a steady current through a vacuum tube and in particular he measured the potential gradient throughout the length of the tube, demonstrating, for the first time, the presence of free electric charges in the path of a circuit carrying a steady current. Partial accounts of this work may be found in J. J. Thomson's "Conduction of Electricity through Gases;" in Winkelmann's "Handbuch der Physik;" in Muller-Pouillet's "Lehrbuch der Physik;" and, in fact, in almost any recent standard work which deals with this department of



P. SANFORD RILEY

physics. Professor Graham's work along this line has been generally regarded as pioneer work on the electric discharge through gases, and a valuable contribution to electrical knowledge, basic to subsequent research.

Professor Graham is a member of the Technology Club of Syracuse, Fellow of the American Association for the Advancement of Science, member of the Astronomical and Astrophysical Society of America, the Societe Francaise de Physique, the American Institute of Electrical Engineers, and the Deutscher Mathematiken Vereinigung.



DR. NORVIN GREEN
(Deceased)

(Extract from "The Telegraph in America," by James D. Reid, Second Edition.)

Norvin Green, President of the Western Union Telegraph Co., from 1878 to 1893, was born in New Albany, Indiana, April 17, 1818. While yet a mere child his family removed to and settled permanently in Kentucky, so that his early life was identified with and fashioned by residence in that State. In his youth he was distinguished by the quiet sagacity and humor which he still retains, by facility in study, and by a coolness of judgment which gave him influence among his associates. Dr. Green's education was thorough rather than broad. His studies were such as suited the professional life he had proposed to enter. His preferences were in the direction of solid knowledge rather than of classic culture. With such tendencies, and after a thorough course of study under the able faculty of the Medical Department of the University

of Louisville, he graduated in 1840 with honor. Thus qualifying himself for his profession he entered upon a successful practice. Not long afterward he became physician of the Western Military Academy at Drennon Springs, Ky., of which James G. Blaine was at that time one of the junior instructors.

Before commencing his medical studies, and while in his sixteenth year — a period in a Kentucky boy's life when adventure is full of charm — he procured a flat-boat and determined to try his luck running a floating grocery down the Mississippi. A load of goods was bought — cottons, calicoes, tinware, boots, groceries, everything needed in such a trade. The craft was launched, full of hope. A lad some years older, skilled in barter, went with him. His chief customers were lumbermen, who, at certain seasons, entered the low river lands to make rafts ready for floating out on high water. Trade was good, and a violin made the woods laugh nights when a merry tune from the deck of the floating grocery broke their sombre silence. It was a plucky thing for a sixteen-year-old boy. The trip was a success and a good many orders had to be sent by returning steamers for fresh goods. His credit must have been good. All orders were honored. The demand for "iron boots," as the huge stogas of the lumbermen were called, was brisk and profitable. It was a good experience, and developed self-reliance.

Of one unusual faculty young Green could boast. He was a great jumper. He could jump backward or forward equally well. His muscles were so under his control that he could make a ten-foot standing jump forward, and then without turning, jump back to the score-mark. Whether this indicated equal hindsight and foresight is a question. Most people have the former prominent enough. The gift of jumping back, when it can be done gracefully, is sometimes valuable and convenient.

Like almost all young men of spirit in Kentucky, Dr. Green early connected himself with the politics of the State. With much native talent as a ready speaker, he soon became prominent. His humor, always ready, made him attractive and popular. He could, on occasion, take his Cremona, and, seated on a stump or upturned box, make a Kentucky barbecue lively. Politics in Kentucky had peculiar methods. Young men did not meet in rented halls and yell over candidates for office. They selected some sweet-scented pastureground near a running stream, where the trees were large and umbrageous.

Dr. Green was elected for several terms to membership of the Kentucky Legislature, and in 1853 was appointed Commissioner of the United States in charge of construction of the National Buildings in Louisville. While engaged in the duties of this appointment he became one of the lessees of the United Morse and People's Telegraph lines between Louisville and New Orleans, and becoming president of these interests united, under the name of South Western Telegraph Company, he became henceforth identified with the history of the Telegraph. In 1866, when the American, United States, and Western Union lines were consolidated, Dr. Green was chosen Vice-President, and with the exception of about three years, during which he accepted the presidency of the Louisville, Cincinnati and Lexington Railroad Co., retained that office until January, 1873, when he returned to duty as Vice-President of the Western Union Telegraph Co. It was during this interim of three years, during which he again entered the political discussions of Kentucky, that he was waited upon by a large delegation from the Kentucky Legislature and urged to accept a nomination for United States Senator against two other candidates, and to which he would have been elected but for a clerical error in the count at the nominating convention. The telegraph gained what the State lost.

Dr. Norvin Green became President of the Western Union Telegraph Company April 22, 1878, and held that office until his death on February 13, 1893.

EDWARD B. HATCH

EDWARD B. HATCH

Edward Buckingham Hatch was born at Hartford, Conn., December 20, 1861, the son of George Edwin and Laura Stanley (Styles) Hatch. His paternal ancestors came to this country from England in 1635 and settled in Falmouth, Mass. They took a leading part in the young country's struggles and governmental affairs. George E. Hatch was a Hartford merchant and much interested in civic matters. His son, Edward B., obtained his early education at the public schools of Hartford, his preparatory work for college being done at the Hartford high school. From there he entered Trinity College, Hartford, in 1882, and was graduated Bachelor of Arts in 1886. That year there was organized in Hartford a new manufacturing concern known as the Johns-Pratt Co., the officers being Mr. Johns, president; Charles H. Patrick, vice-president; Rufus N. Pratt, secretary and treasurer, and young Hatch as a clerk. The capitalization was $100,000 and the product of manufacture was "Vulcabeston" packings and electrical insulation. In 1892 the capital was increased to $150,000 for the purpose of enlarging the factory and providing facilities for the manufacture of overhead trolley line material. In 1898 the company began the manufacture of "Noark" fuses and electric protective devices. Starting at the bottom, Mr. Hatch familiarized himself with every department of the business, and developing marked ability, he was advanced step by step till in 1901 he was made president and treasurer of the company, a position he still holds. Under his management the company has been compelled from time to time to increase the size of its plant, until today it ranks as one of the leading industries of New England. In 1906 by a stock dividend of 100 per cent, the capital was increased to $300,000, and in 1914 it was still further increased to $450,000. While it may not be known as a one-man concern, the growth and success of the company is due in a large degree to the executive ability and business judgment of its president, Mr. Hatch. The factory consists of eleven buildings, employing about five hundred hands. The company holds patents of a very wide range, covering electric protective devices and their accessories. The H. W. Johns-Manville Co. of New York are the sole selling agents, and through their many branches the products are distributed throughout the world under the trade-marks "Vulcabeston," "Noark" and "J. P. Co." Mr. Hatch is a director of the Hartford National Bank, the Dime Savings Bank of Hartford, the Hartford Steam Boiler Inspection and Insurance Co., the Standard Fire Insurance Co., the Hartford County Mutual Fire Insurance Co., the Holyoke Water Power Co., the Franklin Electric and Manufacturing Co., the Johns-Pratt Co., the Jewell Belting Co. and the Hart and Hegeman Manufacturing Co. He is also a trustee of Trinity College and of the Colt Estate Corporation, which is in charge of the estates left by Colonel Samuel Colt and his widow. He is also active in social, fraternal and church life. High up in Masonry, he is a member of St. John's Lodge of Wolcott Council, of Pythagoras Chapter of Washington Commandery, Knights Templar, and of Sphinx Temple of the Mystic Shrine. He is a member of the Hartford, Farmington Country, Hartford Golf, Twentieth Century, Republican, University, Electrical Manufacturers' clubs and of the Alpha Delta Phi fraternity. He is a vestryman and treasurer of Trinity Episcopal Church of Hartford and a member of the Church Club of Connecticut. He has also been identified with the military organizations, having served several years as a member of Company K, 1st Regiment Connecticut National Guards. Mr. Hatch was married at Hartford, Conn., September 12, 1889, to Georgia, daughter of the late George W. Watson, by whom he has three children, Helen, James Watson and Edward Watson Hatch.

WARD HARRISON

At the head of the largest staff of Illuminating Engineers, Mr. Harrison has contributed materially to the progress and literature of the art in this country. He was born in East Orange, N. J., May 16, 1888, graduated from Stevens Institute of Technology in 1909, standing highest in his class, and the same year entered the Engineering Department of the National Lamp Works at Cleveland. He advanced steadily and since 1914 has held the position of Illuminating Engineer. Two problems which have occupied much of Mr. Harrison's thought are street and industrial lighting. In the Cleveland street lighting lantern he has demonstrated how, by the use of crystal diffusing glassware, a scientific control of light can be retained in fixtures of ornamental design. The Reflecto-Cap Diffuser, for minimizing glare in factory installations, is another of his original developments. His work invariably shows an appreciation of the importance and possibilities of aesthetic values in illumination design combined with a characteristic insistence upon the application of thorough engineering methods in securing these desired effects most efficiently. In consequence he has been called upon to act in an advisory capacity to the architects and owners of practically every public and semi-public structure projected in Cleveland in recent years. Mr. Harrison is past vice-president of the Illuminating Engineering Society; member of the Association of Iron and Steel Electrical Engineers (where he has been in considerable measure responsible for present lighting practice in steel mills); the National Electric Light Association, National Commercial Gas Association, Electrical League of Cleveland, Jovian Order and the Tau Beta Pi Fraternity.

FRED S. HARTMAN

Fred S. Hartman, district manager of the Power and Mining Department of the General Electric Company, New York City, is an electric engineer of long experience with various companies. He was born in Fort Wayne, Indiana, in 1873, and was educated at Purdue University, grad-

FRED S. HARTMAN

uating in 1896 with the degree of B. M.E. Previous to graduation he worked in the testing departments of the Fort Wayne Electric Company during his summer vacations. In sequence he filled the position of designing engineer with the Fort Wayne Electric Corporation; assistant to the chief engineer of the Siemens & Halske Electric Company of America, Chicago, Ill.; commercial engineer and manager of apparatus department of the Fort Wayne Electric Works; General Manager of the Mechanical Appliance Company, Milwaukee, Wis.; sales manager Northern Electrical Manufacturing Company, Madison, Wis.; after which he was appointed to his present position. Mr. Hartman is a member of the National Electric Light Association, the American Institute of Electrical Engineers, New York Electrical Society, Jovian League, Engineers Club, Machinery Club, Country Club of Glen Ridge, N. J., Purdue Club of New York, the Tau Beta Pi Alumni Association and the Phi Delta Theta fraternity.

JOHN C. HATZEL

John C. Hatzel, electrical engineer and contractor, was born in New York City June 21, 1860, and was educated in the public schools and at the College of the City of New York. He also attended the New York Nautical School and was an officer of the merchant marine for several years. In 1881 he entered the employ of the Edison Electric Light Company in the construction department, and continued in that position with the Edison Company for Isolated Lighting, until 1884, when he was appointed superintendent of construction of the Southern Department of the company with headquarters at

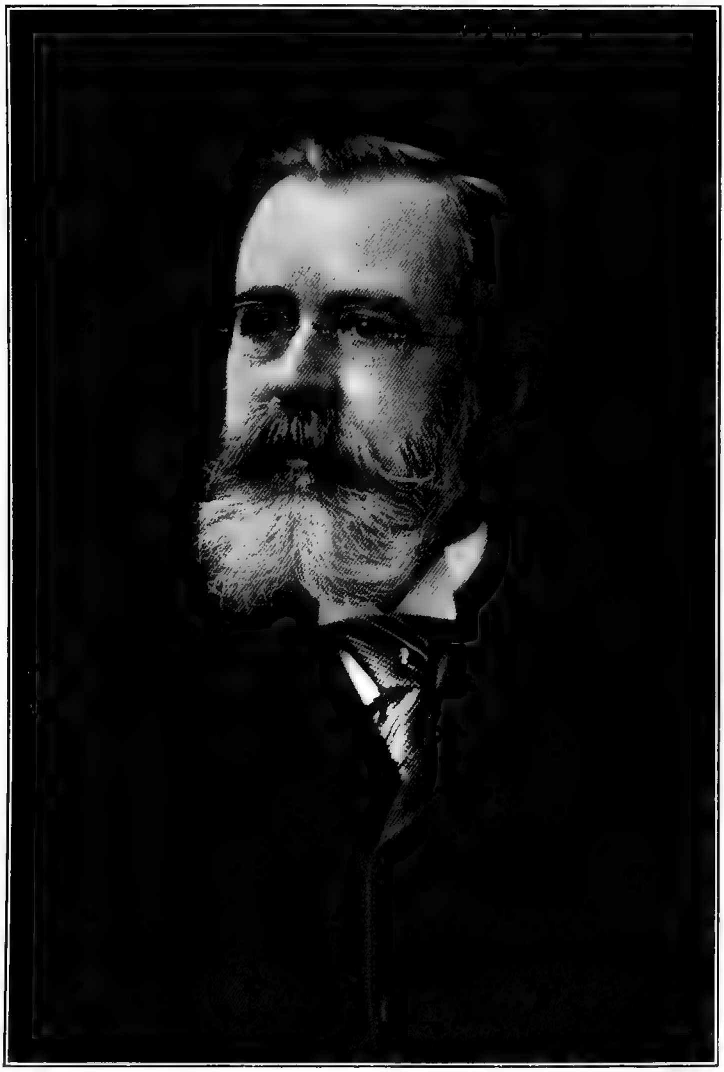
JOHN C. HATZEL

Baltimore. In 1885 he engaged in the electrical engineering and contracting business for himself, installing central stations and isolated plants throughout the country. In 1888 he was made president of the Western Edison

Company, representing the Edison Company's interests in Colorado, Utah and New Mexico. Returning East in 1889, he formed a partnership with Joseph Buehler, under the firm name of Hatzel & Buehler. This connection continued until February 1, 1911, when Mr. Buehler retired and Mr. Hatzel continued the business alone. During the intervening period he has been engaged in much important work, and has made installations in all parts of the country. In April 1917, incorporated, associating with him Messrs. Allan Coggeshall, Chas. Metzger and Harry J. Kurrus, as Hatzel & Buehler, Inc. He is well known in electrical circles and is always interested in any movement that will benefit his profession. He is a member of the American Institute of Electrical Engineers, the New York Electrical Society, Illuminating Engineering Society, American Electrochemical Society, National Electrical Contractors' Association, Electrical Contractors' Association of New York State, Electrical Contractors' Association of New York City, Building Trades Employers' Association, Board of Governors, New York State Nautical School, Alumni Association New York Nautical School, Engineers' Club, Newport Yacht Club, Jovian Order, Metropolitan Museum of Art, Chamber of Commerce, State of New York, Red Cross and the Navy League. Mr. Hatzel's offices are at 373 Fourth Avenue. He resides at 89 West 119th Street, and passes the summer months at Newport, Rhode Island.

DR. CARL HERING

Dr. Carl Hering, of Philadelphia, distinguished as electrical and electro-chemical engineer, was born in Philadelphia, March 29, 1860, the son of Dr. Constantine and Theresa (Buchheim) Hering. His father, who was a well-known physician in Philadelphia (1833-1880), was affectionately known as the Father of Homeopathy in America, and his grandfather, whose ancestors came from Moravia, was a composer of some of the folk-songs of Germany. Dr. Carl Hering's educational training was received in private schools in Philadelphia and the University of Pennsylvania, from which he was graduated B.S. in 1880 and received the post-graduate degree of M.E. in 1887. He took a special course in electricity at Darmstadt, Germany, in 1883-1884, and received the honorary degree of Doctor of Science from the University of Pennsylvania in 1912. He began his professional career as chief engineer of Henry Moehring & Co., manufacturers of electrical machinery, in Frankfort-on-the-Main, Germany, 1884-1885, after which he started practice in Philadelphia as consulting electrical engineer, in which profession he has ever since continued. He has held temporary engagements with various companies in the United States, chiefly as a consultant, and in many cases of patent litigation, some for and some against the large companies. His has been a constructive career, largely devoted to numerous efforts to bridge the gap between pure and applied science (engineering), physics and physical chemistry. His early work was very largely experimental in days when research was pursued with little of the data which are now available to all students. Dr. Hering was a delegate of the United State Government, of the American Institute of Electrical Engineers and of the Franklin Institute to a number of international congresses, meetings and expositions abroad, and made the official reports to the Government on the subject of electricity at the Paris expositions of 1889 and 1900. He has been a member of the Jury of Awards or Scientific Commissions at twelve expositions and was one of the ten distinguished engineers who were requested to found an American Academy of Engineers in 1917. He was the author of "Dynamo Electrical Machines," published in 1888, the first book on dynamos published in this country; also of "Conversion Tables" and several other books and of many papers read before technical societies, also many articles in

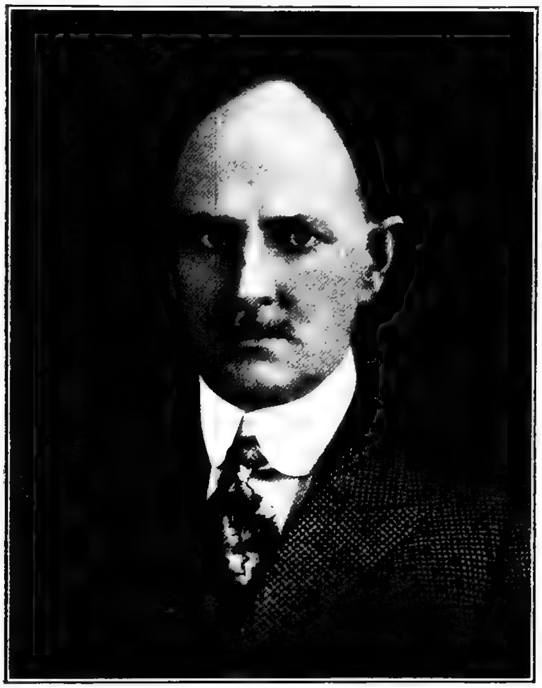


DR. CARL HERING

technical journals. He originated and conducted the "Digest of Electrical Literature" in the *Electrical World,* 1891 to 1901, and was the technical editor of that journal in 1891. Dr. Hering is past president of the American Institute of Electrical Engineers, the American Electro-Chemical Society and the Engineers Club of Philadelphia. He was one of the three original founders of the American Electro-Chemical Society; was United States delegate to the International Society of Electricians at Paris for twenty-five years; is an honorary member of the New York Electrical Society, and a member of many other technical or professional societies. Dr. Hering has been one of the pioneers in the development of electrical science and industry. He started the first comparative life tests of incandescent lamps in 1884; discovered the "Pinch effect" in electric furnaces, a new thermal law, the error in the usual statement of Maxwell's law of induction, and pointed out other errors, looseness and inconsistencies in physical laws, units, expressions, nomenclature, etc., and has helped most effectively to make order in the physical sciences. He was decorated twice by the French Government, in 1889 with the "Golden Palms" (purple button) and in 1901 with the Legion of Honor (red ribbon).

HALBERT P. HILL

The experiences of Halbert P. Hill as an electrical engineer began unusually early in life and show throughout an exceptional degree of diversity. His inherited instincts were positive guides in his preference for mechanics and electrical science. So it was that he broke away from theological studies which he had been sent to pursue at St. Minard's College of the Benedictine Monastery in Spencer Court, Ind. He was born at Memphis, Tenn., November 3, 1873. One of his ancestors was C. A. Spencer, a grandfather on his mother's side, who was the inventor of the Spencer rifle, which made a record in the Civil War. Regardless of his youth, young Hill upon leaving college entered the electrical business on his own account. By 1891 he was an electrical contractor in Evansville, Ind. Before he reached his majority he had built three electric light and power plants. His remuneration for the last one had to be collected by his guardian when it became known that he was a minor. Mr. Hill's inventive effort is manifested in untiring research along the lines of electrical and electro-therapeutical experiment, and also in experimentation upon chemical apparatus and alternating current phenomena. The patents he holds, besides relating to the foregoing subjects, include steam turbines, gas producers and synchronous motors, etc. Simultaneously with the establishment in New York City of an independent practice as a consulting engineer upon power plant designing and construction of special electrical apparatus, Mr. Hill was manufacturing in Washington, D. C., the "Hill Apparatus." This designation comprehended the production of several important pieces of electrical machinery, including the building of one of the first lines of small multipolar motors. Small synchronous motors were developed for the operation of X-ray machines; a system of wireless transmission was devised, transmitting power successfully over short distances; and out of the same laboratory and manufactory came an improved equipment for high voltages for transformers, switches and rectifiers for electrical precipitation (Cottrell System) and for similar purposes. Mr. Hill is responsible for a gas producer, making clean gas from coal, lignite, or peat, which is used in gas engines; and he is also the designer of the principal plants where the process is employed. He has developed an improved method of ice-making, and invented new electro-chemical apparatus for manufacturing chlorine. His improvement of the start and pull-in characteristics of synchronous motors made that form of equipment more adaptable for connections to ammonia and air compressors. He has given valuable aid to the improvement of central stations by correcting power factors and compiling new rates, proving that rates at low power factor should be higher than at unity power factor. Mr. Hill is a member of the New York Electrical Society, the American Institute of Electrical Engineers, the Sons of Jove and the Franklin Institute. He is vice-president of the New York firm of Ophuls, Hill & McCreery, Inc., consulting engineers at 112 West 42nd Street.


HALBERT P. HILL

NICHOLAS S. HILL JR.

NICHOLAS S. HILL, JR.

The services of Nicholas S. Hill, Jr., have, on many occasions, been sought by municipalities and corporations to solve intricate engineering problems requiring expert knowledge. Unusual initiative and his accomplishment along these lines have brought him a nation-wide reputation. Mr. Hill was born in Baltimore, Md., June, 18, 1869, where he attended private schools and afterwards entered the Stevens Institute of Technology, graduating in 1892, valedictorian of his class. Previous to his collegiate course he gained a practical knowledge of engine construction and machinery by serving time in the shops and drafting room of the Baltimore & Ohio Railroad at Mt. Clare and Newark, Ohio. His first appointment after graduation was in charge of the construction and inspection of the motive power and car equipment of the South Side Elevated Railroad in Chicago. After the completion of this equipment he was appointed mechanical engineer in charge of motive power, shops, rolling stock and power stations. He remained with this company for a year and a half, when he came east and assumed the position of engineer and secretary of the Sewerage Commission of Baltimore, Maryland, which had in hand the preparation of a report and preliminary plans for a general sewerage system and the disposal of the sewage of the entire city of Baltimore. In 1894 he was appointed engineer of the Electric Commission of Baltimore, having in charge the designing and construction of an underground conduit system for the police and fire alarm telegraph wires of that city. After completing this work, he recommended to the city the construction of a municipally owned conduit system to accommodate all of the then overhead wires in Baltimore. This recommendation was adopted and plans for the general system were prepared, the necessary legislation and appropriation secured and the work of construction started. This is the only municipal conduit system in operation, except perhaps Chicago, in the United States, and it has conserved the subsurface space of the streets of Baltimore for future useful purposes, and while the charges for this service are reasonable, they have netted the city a revenue that has been sufficient to make the plant self-supporting. In 1896 Mr. Hill was appointed chief engineer of the water department of Baltimore, with a special view to reorganizing this department and putting it on a proper working basis, and in this position he was in charge of improvements for which about two million dollars had been appropriated. The work was successfully carried through in 1896-7 and in 1898, owing to political changes, he was forced to resign. He then took up practice as a consulting engineer in Baltimore and during this period was retained by financial interests to make a number of reports on properties in the south, including street railways, electric light and hydraulic power stations, and at the request of these interests he accepted the position of chief engineer of the Charleston (South Carolina) Consolidated Railroad, Gas and Electric Company, for the purpose of rehabilitating these properties, which work was consummated during the years 1898-9. In 1900 he came to New York City and opened an office as consulting engineer, 100 William Street, where he is still practicing. In 1902 he was appointed chief engineer of the Department of Water Supply, Gas and Electricity, in charge of the water supply of the City of New York. He filled this position for two years and then gave his entire attention to private practice, which he had not relinquished while with the city. At the present time Mr. Hill's principal work is hydraulic and sanitary engineering, with water supply, hydraulic power developments and sewage disposal. Mr.

Hill has been retained as consulting engineer by a number of cities and towns in the United States, including Birmingham, Ala.; Binghamton, N. Y.; Easton, Pa.; East Orange, N. J.; Geneva, N. Y.; Jersey City, N. J.; Kingston, N. Y.; New York City, N. Y.; Norfolk, Va.; Norwich, Conn.; Rahway, N. J.; Rochester, N. Y.; South Orange, N. J.; Troy, N. Y., etc., etc. He has also been retained by a large number of water companies, and these include the Citizens' Water Supply Company, Elmhurst, L. I.; Consolidated Water Company of Suburban New York, Tarrytown, N. Y.; Defiance Water Company, Defiance, Ohio; Elizabethtown Water Company, Elizabeth, N. J.; Great South Bay Water Company, Bay Shore, L. I.; Hackensack Water Company, Weehawken, N. J.; Jamaica Water Supply Company, Jamaica, L. I.; Lake Charles Railway, Light and Water Works Company, Lake Charles, La.; New York and New Jersey Water Company, Bayonne, N. J.; Rochester and Lake Ontario Water Company, Rochester, N. Y.; Queens County Water Company, Far Rockaway, N. Y.; Woodhaven Water Supply Company, Woodhaven, L. I., etc., etc. Among the trust companies and bankers who have sought Mr. Hill's assistance in investigations and reports are: The Baltimore Trust and Guarantee Company; the Guaranty Trust Company, New York City; Kean, Taylor & Co., New York City; Kissell, Kinnicutt & Co., New York City; Mercantile Trust and Deposit Co., Baltimore, Md.; the West End Trust Co., Philadelphia, Pa., etc., etc.

Mr. Hill is a resident of East Orange, N. J., and is deeply interested in the development of his home city. He is chairman of the Water Board operating the Water Department of that city and is a vestryman of Christ Church. He is very domestic in his tastes, is fond of all outdoor amusements and is interested in many social service and charitable organizations. He is the author of many technical papers and has been a frequent contributor to publications devoted to his line of work. He was a member of the executive committee of the American Street Railway Association 1896-9 and at present holds membership in the American Institute of Consulting Engineers, American Society of Mechanical Engineers; member committee on memberships: American Society of Civil Engineers, American Society for Testing Materials, American Water Works Association; member executive committee and president 1915-16: New England Water Works Association, American Public Health Association, American Society of Municipal Improvements, Municipal Engineers of the City of New York, American Academy of Political and Social Science, National Economic League, American Geographic Society, Railroad Club of New York and associate member of the American Institute of Electrical Engineers. Mr. Hill was also a member of the executive committee of the Stevens Institute Alumni Association and at the present writing is its president. He is also a member of the Rho Chapter of the Delta Tau Delta Fraternity. Mr. Hill operates in conjunction with S. F. Ferguson, another engineer of note, and employs a staff of competent engineering assistants, chemists and bacteriologists. The laboratories at 100 William Street are thoroughly equipped for analyzing water, sewage and alloys and the testing of coal, sand and cement. Special attention is paid to public utility valuations and the design, construction and operation of water supplies, water power developments, filtration plants, pumping stations and sewage disposal works.

ALFRED J. HIXON

ALFRED J. HIXON

Alfred J. Hixon, president of the Hixon Electric Company of Boston, Mass., has attained an important place in the electrical field although comparatively a young man. The Hixon Electrical Company has successfully carried out some of the largest contracts in New England; a notable instance was the installation of all electrical material in the tremendous military cantonment at Ayer, Mass., known as Camp Devens. Many records were broken by the contractors for the war camps throughout the country and the Hixon Company did its part, despite all handicaps, to have the quarters ready and waiting when needed. Alfred J. Hixon has been honored by his associates in the Electrical Contractors Association of Massachusetts with the election to the presidency of that organization which has for its object the improvement of conditions under which electrical contracting may be conducted; to oppose unfair legislation; to acquaint its members with improvements in the science and to generally effect a closer relationship between its members for their mutual good. Mr. Hixon's virile personality worked strongly for the Association's benefit during his occupancy of the chief office. Mr. Hixon began his practical electrical career early in life, which fact possibly accounts for his present prominent place at so early an age. Born in San Jose on September 1st, 1876 he was graduated from the public schools of that beautiful California city in 1891. Naturally of a mechanical turn of mind his desire was to seek the most promising place where that bent might be utilized and also in a district more pronounced in its aggressiveness than the sleepy atmosphere of his native Pacific, and we therefore find him at the age of sixteen working on the line of the Northwestern Telephone Company, and thus, as Mr. Hixon naively expresses it, his electrical education was gained by "climbing poles" for this company, a school from which many of our best and most successful men hold degrees. Successively, from the pole climbing job, Mr. Hixon was connected with the Western Electric Company, at Chicago, the Franklin Engineering Company, also of that city, and with Edwin C. Lewis, Inc., the Boston electrical contractors, from which work he withdrew to organize his own company and to become known throughout New England as one of the most responsible in his chosen field.

HERBERT THACKER HERR

Herbert Thacker Herr, who is now vice-president of the Westinghouse Electric and Manufacturing Company, has worked his way forward to that position by successive demonstrations of executive ability and engineering skill.

He was born in Denver, Colorado, March 19, 1876. His paternal ancestry is traced back to the year 1009, to the Schwabian Knight Hugo, Lord of Bilried, and his first American ancestor was Rev. Hans Herr, who settled in Lancaster County, Pennsylvania, in 1709, arranging terms to colonize with William Penn. Mr. Herr's parents, Theodore W. and Emma (Musser) Herr, were natives of Lancaster, Pa.

He was educated in the Denver public schools, and later became a student in the Sheffield Scientific School of Yale University, from which he was graduated in 1899 with the degree of Ph.B., and election to

Sigma Xi, having taken the prize in mathematics. He became a member of Delta Phi fraternity while at Yale. Before entering college he had served as machinist's apprentice with the Chicago and Northwestern Railroad.

After graduation he entered the service of the Denver and Rio Grande Railway Company, for two years as machinist and draftsman, and was chairman of a committee to revise the operating rules of that company. In 1902 he went with the Chicago Great Western Railroad Company as master mechanic at Des Moines for a year and at St. Paul for six months; then with the Atchison, Topeka and Chicago Railway as master mechanic of the Chicago Division at Fort Madison, Iowa, for a year; then for eighteen months master mechanic of the Eastern Grand Division of the Norfolk and Western Railroad Company at Roanoke, Virginia. He was then appointed assistant to the Vice-President of the Denver and Rio Grande Railroad, becoming general superintendent of that road in 1906. He retired from railway service to become Vice-President and General Manager of the Duquesne Mining and Reduction Company of Duquesne, Arizona.

From there he went to Pittsburgh, Pa., becoming closely associated with the late George Westinghouse during the last seven years of that inventor's life. In 1908 he became general manager and soon after Second Vice-President and General Manager of the Westinghouse Machine Company, and Vice-President of that company in 1913, and he is now Vice-President of the Westinghouse Electric and Manufacturing Company, Vice-President and director of the Westinghouse Gear and Dynamometer Company, director of the Rodman Chemical Company and the Westinghouse Export Company, and various other companies.

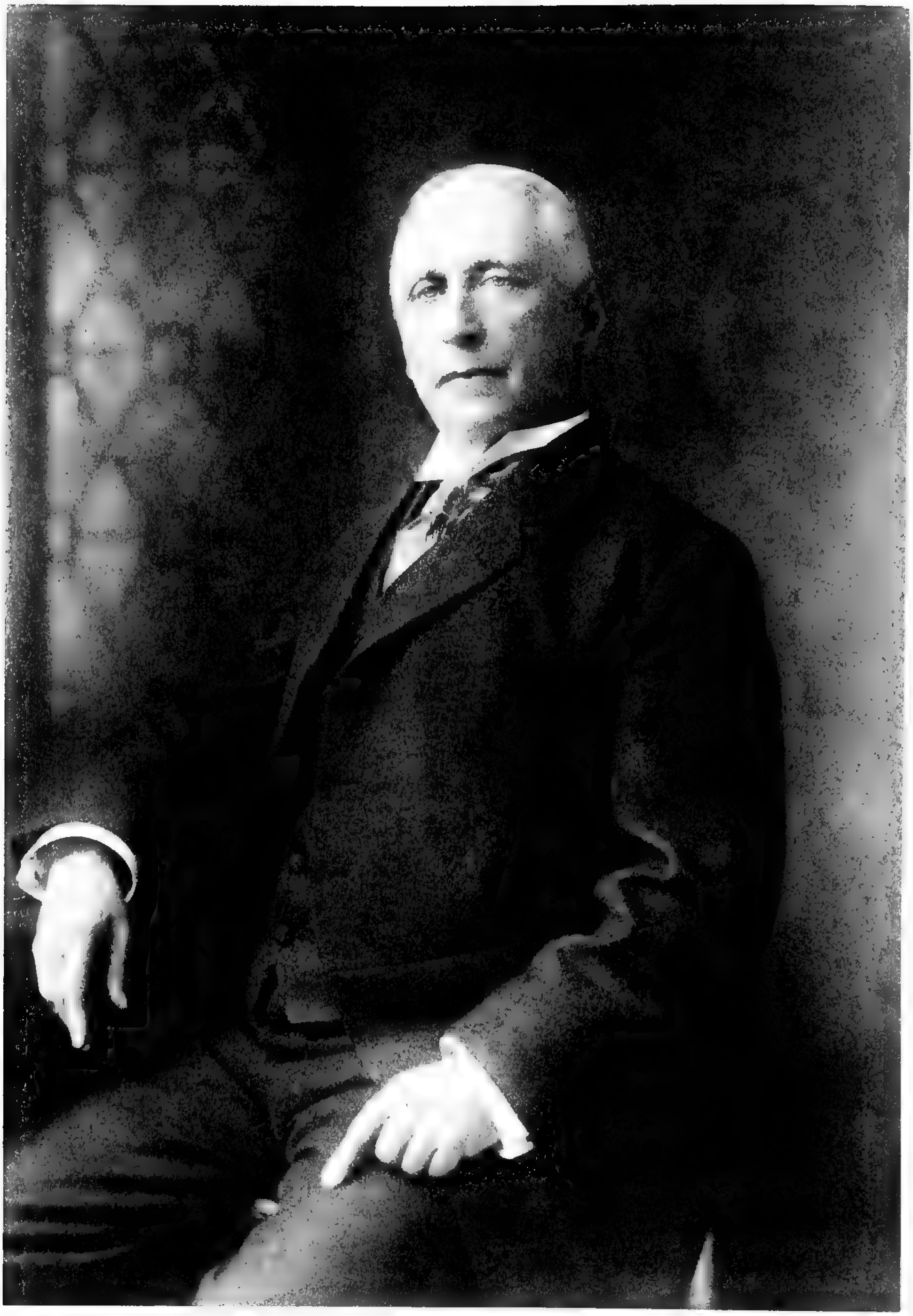
He is a member of the American Railway Guild, the American Institute of Mining Engineers, American Society of Mechanical Engineers, American Society of Automobile Engineers, American Society of Naval Architects and Marine Engineers, the Yale Engineering Club, Duquesne Club of Pittsburgh, the New York Yale Club, Bankers' Club and the Engineers' Club of New York.

HARRY ARCHER HORNOR

Harry Archer Hornor is lineally descended from a prominent English family of that name. His first American ancestor was a Quaker, who settled in 1683 on an estate at Bordentown, New Jersey, the family afterwards removing to Philadelphia. His father and grandfather were both prominent lawyers. He was born in New Orleans, December 5, 1874, attended private schools there until he was fifteen years old, then was with the New Orleans architectural firm of Sully & Co., until 1894, when he left to prepare for college. He entered Trinity College, Hartford, Conn., in 1896; was graduated in June, 1900, with honors in physics and chemistry; was salutatorian of his class, editor Class Annual, College Marshal, manager Dramatics Association and elected to Phi Beta Kappa. He entered the Electrical Department of the New York Shipbuilding Company (now Corporation), at Camden, N. J., on July 2, 1900; was given charge of the marine electrical drafting in 1901, and since 1905 has been at the head of the electrical department of that corporation, both plant and construction. He resigned from the New York Shipbuilding Corporation the first of February, 1918. Since that time he has been devoting his technical experience to the investigation of the applicability of electric welding to shipbuilding for the United States Shipping Board, Emergency Fleet Corporation. Among his achievements was the installation in the plant of alternating current-motors; the first extensive application of alternating current for industrial use in this country. The energy was derived from double current generators, taking both alternating current and direct current from the same armature and field. These are the only generators of this type in this country. The installation of the first direct-current, direct-connected turbo-generating set installed for the United

HARRY ARCHER HORNOR

States Navy was done at his suggestion and under his direction on the battleship "New Hampshire." There were two sets, of 200-kw. capacity. The first installation of lead-covered steel armored conductors, instead of wires drawn through conduit, was made at his suggestion and under his direction for the U. S. battleship "Oklahoma." This followed a similar installation on the Argentine battleship "Moreno," also done under his direction. The first application of electric propulsion for merchant vessels in America is now being undertaken by the Pennsylvania Shipbuilding Company under his professional advice. Mr. Hornor is a fellow of the American Institute of Electrical Engineers, vice-president of the Illuminating Engineering Society, Franklin Institute, Physics Club of Philadelphia, Philadelphia Association of Alpha Delta Phi, and treasurer of the Browning Society of Philadelphia.



CHARLES W. HOLTZER

CHARLES W. HOLTZER

A career of progress that has run parallel with the development of the electrical industry is that of Charles W. Holtzer, now president of The Holtzer-Cabot Electric Company of Boston. His training from boyhood has been in connection with industries of scientific bearing. Soon after the Civil War he was engaged with his father in the carrying on of experiments intended to improve ammunition for artillery use. After that work had been discontinued he engaged with the firm of George M. Stevens & Company, who were manufacturers of tower clocks. From that connection he went with the firm of E. S. Ritchie & Sons, at Brookline, Massachusetts, engaging in the manufacture of philosophical instruments. A connection of several years with that enterprise, the products of which were instruments of precision, was a good preparation for the line of industry which was to become his life work. He became interested in matters electrical, and severing his connection with E. S. Ritchie & Sons he embarked in business in a small way on his own account in the manufacture of electrical apparatus, including such devices as electric annunciators, bells, batteries, electro-mechanical gongs for fire alarms, etc. He soon added new products to his list, taking out several patents on electric time recorders, fire alarm bells and electric gas-lighting appliances.

The year 1875, when Mr. Holtzer started this business, was in the period when some of the greatest minds were engaged upon the solution of electrical problems, and the world was soon to be astounded by epochal discoveries and developments which would apply electricity to transmitted speech, to great purposes in the generation and distribution of light and power, and would add year by year to the invention and improvement of mechanisms which should harness electricity to various uses.

Soon the invention of the telephone had so advanced as to open up for Mr. Holtzer a considerable addition to his business in the manufacture of telephone supplies. He opened the first branch exchange under the Bell license in Brookline, beginning with fourteen subscribers and one trunk line to the Boston Exchange. Mr. Holtzer conducted the Brookline exchange, with steady increase in subscribers, until 1880, when he sold his telephone contract to the Suburban Telephone Company. The growth of its business is indicated by the fact that on January 1, 1918, the Brookline exchange had 12,368 subscribers.

Soon after the telephone was introduced electric lighting began and the manufacture of incandescent lamps was started. Mr. Holtzer fitted up the factory of the Brush-Swan Incandescent Lamp Company with appliances for their manufacture, and soon after similarly equipped the plant of the Schaefer Incandescent Lamp Company. He took out some patents on incandescent light fixtures and switches and enlarged the scope of his own business by adding full lines of apparatus and supplies for electric lighting.

Electricity for transmitted power was the next of the major developments in the electrical industry, and was one in which Mr. Holtzer was one of the pioneer participants. The first dynamo he built was from the design of William Stanley, who at that time was connected with the Brush-Swan Incandescent Lamp Company and later was engineer for the Westinghouse Electric Company, as well as for the Stanley Electric Manufacturing Company. From this was developed a diversified line of motors and dynamos, keeping place with the progressive development of varied types of dynamo-electric machinery; and the department of electric power has been developed into a leading feature of the industry.

From the first workshop in a room ten by twelve feet, in which the business began in 1875, it has expanded to a plant comprising a monolithic structure 400 feet by 60 feet in size and six stories high, a power house, a factory and a storehouse, all located on a four-acre lot in the Roxbury district of Boston.

In 1889 Mr. Holtzer formed a partnership with George E. Cabot under the name of Holtzer & Cabot, which was later incorporated under the laws of Massachusetts with its present title of The Holtzer-Cabot Electric Company. Three years later Mr. Cabot sold his interest to Mr. Holtzer, who now controls the business.

WILLIAM JOSEPH HAMMER

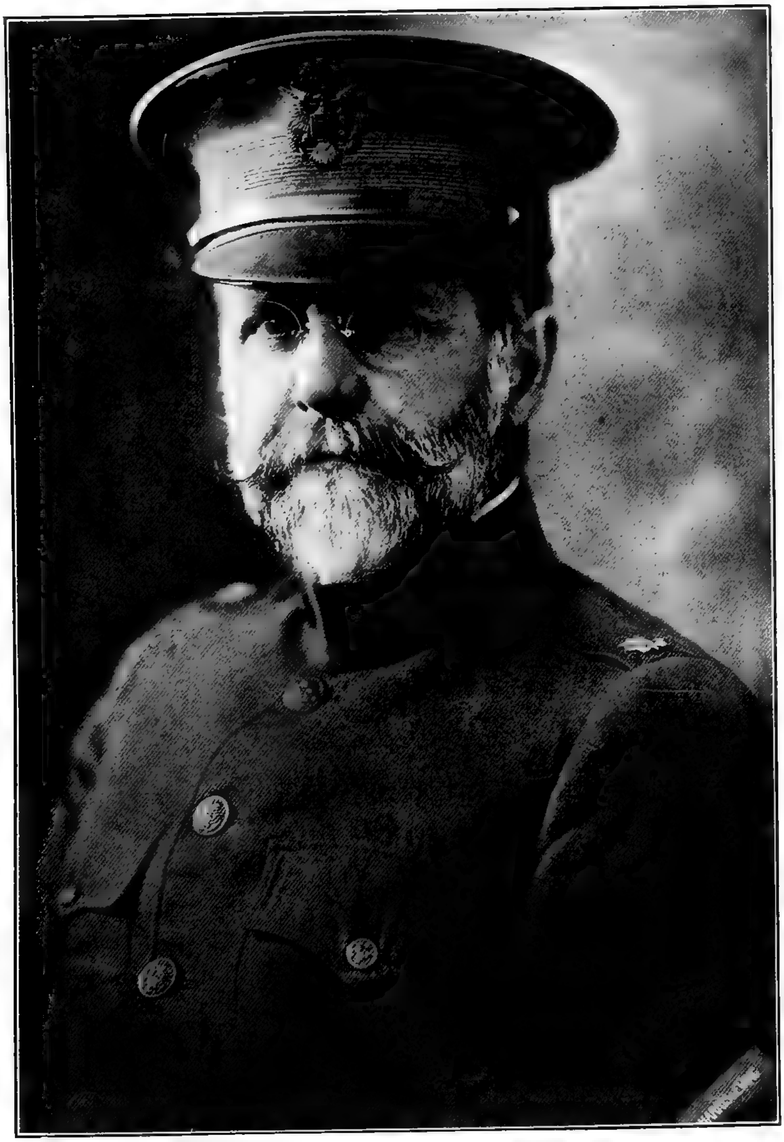
William J. Hammer, whose wide experience as a consulting engineer, in this country, has been supplemented by practice, lectures and study abroad, was born at Cressona, Schuylkill County, Pennsylvania, February 26, 1858, the son of William Alexander and Martha A. (Beck) Hammer. He became assistant to Edward Weston of the Weston Malleable Nickel Co., Newark, N. J., in 1878, and in December of the following year entered the employ of Thomas A. Edison in his laboratory at Menlo Park, N. J. In common with Mr. Edison's other associates he assisted in the experiments on the telephone, phonograph, electric lighting, electric railway, ore separating and other inventions being developed at the laboratory, devoting his attention, however, particularly to the incandescent electric lamp.

Under the direction and supervision of Mr. Edison and his mathematician and partner in the incandescent lamp, Mr. Francis R. Upton, he prepared the original plan and assisted in making the determinations of the underground conductor system of the Pearl Street Station of the New York Edison Co. He had charge of the experimental tests and records of the Edison lamps at the laboratory and subsequently became chief electrician of the first incandescent electric lamp factory at Menlo Park, N. J. In 1881 he was sent abroad by Mr. Edison and became chief engineer of the English Edison Electric Light Co., and associated with Mr. E. H. Johnson, general manager, he constructed the Holborn Viaduct central electric light station in London. This plant contained three 30-ton "Jumbo" steam dynamos, and operated 3,000 incandescent lamps, and on January 12, 1882, Mr. Hammer personally closed the switch which started the operation of this the first central station ever constructed for incandescent electric lighting, the New York Edison station in Pearl Street not being started until September 4 of that year. While in London (1882) he also installed a large isolated lighting plant of twelve Edison dynamos at the Crystal Palace Electrical Exposition. At this time he designed and built the first electric sign ever made; it was erected over the organ in the Crystal Palace concert hall, and spelt the name "Edison" in electric lights, being operated by a hand-controlled commutator.

His work in England brought him offers of the posts of chief engineer from both the French and German Edison companies, and he accepted that of the latter company, the Deutsche Edison Gesellschaft, now known as the Allegemeine Elektricitaets Gesellschaft. He had entire charge of all the installations of the company until the fall of 1884, when he returned to America.

While in Berlin, he invented and built the first automatic motor-driven flashing electric sign in the world. This sign, which flashed the name "Edison" letter by letter and as a whole, was placed on the Edison pavilion at the Health Exhibition in Berlin in 1883, and upon its principle all flashing signs of to-day are based. Returning to the United States, he was put in charge of the Edison exhibits, some eight in number, including Mr. Edison's personal exhibit, at the International Electrical Exposition held under the auspices of the Franklin Institute in Philadelphia in 1884. Mr. Hammer became confidential assistant to Mr. Edward H. Johnson, president of the parent Edison Electric Light Co. in 1884, and later, together with Mr. Johnson and Mr. Frank J. Sprague, became an incorporator of the Sprague Electric Railway & Motor Co., Mr. Hammer being elected a trustee and the Company's first secretary.

Shortly thereafter he was appointed chief inspector of central stations of the parent Edison Co., making electrical, mechanical and financial reports upon the various stations throughout the United States for over two years (1884-1886),



MAJOR WILLIAM J. HAMMER

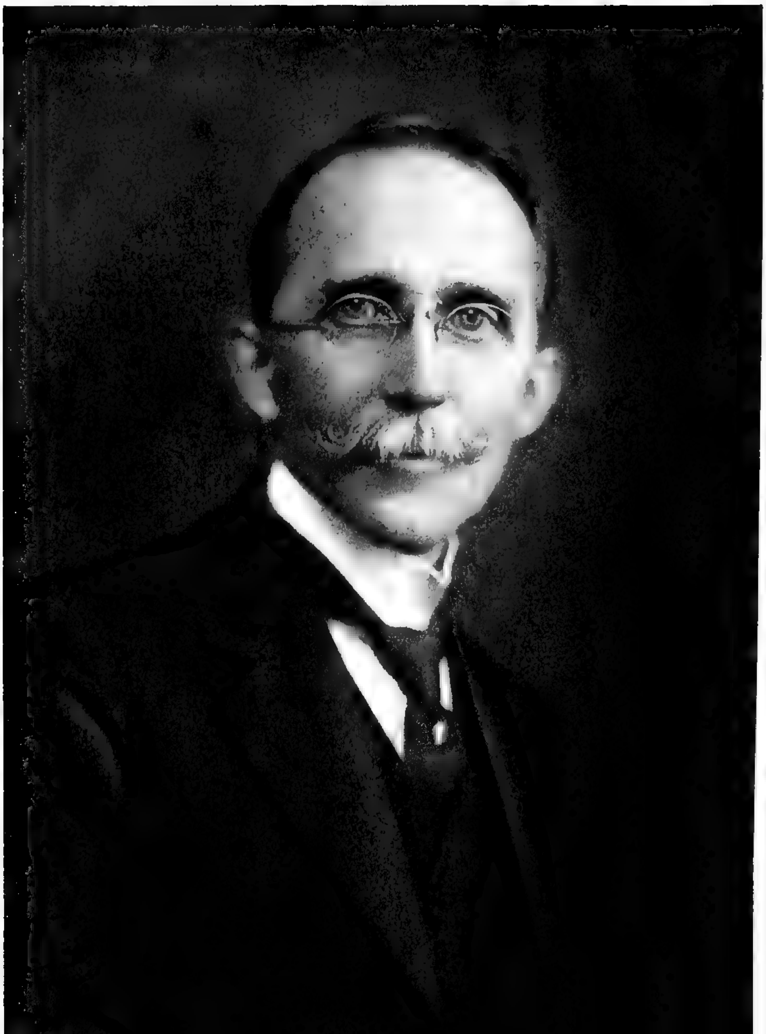
and was next sent to Boston as general manager and chief engineer of the Boston Edison Electric Illuminating Co. In one year's time he changed this plant from a losing investment to one paying twelve per cent. on its capitalization. Acting as a contractor for the company, he installed in Boston the company's elaborate underground system of conductors, and by the installation of ninety-two Sprague electric motors, assisted by the Sprague Company's agents, made this the first plant for the electric transmission of power worthy of the name ever established. Later he took up special expert work for the parent Edison Electric Light Co. in New York, and in 1888 he was placed in charge of the completion and starting of the 8,000-light plant of the Ponce de Leon Hotel at St. Augustine, Fla., which at that time was the largest isolated incandescent lighting plant. Associated with Mr. William Kennish he erected for Mr. Henry M. Flagler the first electric light plant ever run directly by power from an artesian well driving a turbine and dynamo. In 1888 he was appointed consulting electrical engineer to the Cincinnati Centennial Exposition, and as a

contractor devised and constructed the elaborate electrical effects as an attraction to the exposition.

He was next appointed Mr. Edison's personal representative at the Paris Exposition of 1889, at which time he had upward of $100,000 placed at his disposal and a corps of forty-five assistants. The Edison exhibit embraced seventeen departments and covered over nine thousand square feet of floor space. During the exposition he accompanied Mr. and Mrs. Edison to the German Science Congress at Heidelberg, and later to Berlin, where they visited Prof. Von Helmholtz and Dr. Werner Siemens, and at the close of the Paris Exposition Mr. Hammer made a notable balloon flight across France with Dr. A. Lawrence Rotch, Director of Blue Hill Observatory, and Dr. R. G. Wells of St. Louis. During this trip extensive meteorological, magnetic, electric and signalling experiments were carried out. Returning to the United States in 1890, he opened an office in New York City as a consulting electrical engineer, which office he has ever since maintained. Much of Mr. Hammer's professional work has been in connection with tests, investigations and reports upon electrical properties and inventions, and acting as an expert in electric lighting, telephone, storage battery, aeronautical and other patent cases, accident cases, rate cases, etc. He has done considerable original work in his laboratory in connection with selenium, radium, X-rays, wireless, cold light, phosphorescence, fluorescence, etc. He has compiled what is without doubt the most important bibliography upon selenium in the world, and is the possessor of a unique collection of autographed portraits of eminent scientists and engineers, and has had a dozen or more patents issued to him here and abroad upon his inventions.

He has visited Europe frequently to make professional reports on patents and processes, to attend electrical and aeronautical congresses and meetings, and to study and report on developments in science and engineering, such as gas engines, steam turbines, high furnace gas applications, sulphur dioxide gas engines, arc lighting and incandescent lighting, radium, automatic telephony, wireless, the Poulson telegraphone, and various high-tension electric railway plants in France, England, Switzerland, Austria-Hungary, Italy and Germany. Mr. Hammer is a fellow and a life member of the American Institute of Electrical Engineers and a member of the New York Electrical Society (having been vice-president of both), fellow of the American Association for the Advancement of Science and charter member of the Edison Medal Association and the Edison Pioneers.

He was for two terms chairman of the committee on standard rules for electrical construction and operation of the N. E. L. A., and president of the National Conference on Standard Electrical Rules which organization prepared and promulgated the "National Electric Code" now in use throughout the United States; was for two years president of the Franklin Experimental Club; member of the Franklin Institute, the Agassiz Natural History Society (one of the chapters of which was named in his honor), the Aeronautical Society of America, of which he was an incorporator and vice-president, and has been a director since its inception, the Institute of Radio Engineers, and in addition to the above is or has been a member of the Society of Arts, the American Physical Society, the International Society of Electricians, the American Electrochemical Society, the Association of Edison Illuminating Companies, of which he was at one time a director; the Mineralogical Society, the National Electric Light Association, the Illuminating Engineering Society, the Aero Club of America and the Engineers' Club. He was a member of the "Curie" Radium Award Committee of the Franklin Institute, and represented the A. I. E. E. at the "Hall of Fame" ceremonies. He was awarded both the John Scott legacy medal and premium in 1902 and the Elliott Cresson gold medal in 1906 by the Franklin Institute, the former for his telephone relay and long-distance sound experiments, and the latter for his historical collection of incandescent electric lamps. This very complete collection, upon which Mr. Hammer has worked over thirty-four years, is practically a "History of an Art." Its supreme worth, historical importance and value were attested by the award of a special silver medal at the International Electrical Exposition at the Crystal



RUDOLPH MELV LLE HUNTER

Palace, London, England, in 1882, the "Grand Prize" at the St. Louis Exposition of 1904, as well as the Elliott Cresson gold medal of 1906. The collection is now at the Engineering Societies' Building, New York City.

Mr. Hammer was chairman of the jury upon telegraphy, telephony and wireless at the St. Louis Exposition of 1904, and also a member of the "Departmental" jury, and was on the committee appointed to organize the International Electrical Congress at St. Louis in 1904. His book, "Radium and Other Radioactive Substances" (1903), was the first ever published upon that subject, and has gone through many editions here and abroad. He is the author of articles on radium and radio-activity in the Encyclopedia Americana, has delivered eighty lectures on the subject. In 1902 Mr. Hammer invented the radium luminous compounds now so extensively used on watch, clock, and instrument dials, etc. He was one of the editors of "Navigating the Air," the official book of the Aero Club of America in 1907, and was chairman of the general committee of the Jamestown Exposition international aeronautical congress in the same year. In collaboration with Mr. Hudson Maxim, he prepared the "Chronology of Aviation" for the World's Almanac of 1911, subsequently reprinted in booklet form and widely distributed here and abroad, and acted as secretary and expert of the aeronautics committee of the Hudson-Fulton celebration of 1909, and has made a number of airplane flights. He has testified for the Wright Bros. in all their aeroplane suits in this country. Mr. Hammer was married January 3, 1894, to Alice Maude, daughter of Thomas H. White of Cleveland, O., and has one child, Mabel White Hammer.

On June 4, 1918, Mr. Hammer received a commission as Major in the U. S. Army, and was appointed a member of the Inventions Section, War Plans Division, General Staff at the Army War College, Washington, D. C., and on Dec. 13th, 1918, by direction of the President, he was detailed as a Member of the General Staff Corps under the provision of an Act of Congress approved May 18, 1917.

RUDOLPH MELVILLE HUNTER

As mechanical and electrical engineer, inventor and scientist of deep original research, Rudolph Melville Hunter, of Philadelphia, is internationally prominent. He was born in New York City, June 20, 1856, and is of Scotch ancestry dating back to the Hunters of Hunterston in the time of Alexander II of Scotland. He was educated at Edmonton, England; École des Professionales, Monteville, France; Upper Canada College, Toronto, Canada; and Polytechnic College of the State of Pennsylvania, graduating in 1878 with the highest honors in mechanical and electrical engineering. Being in business seven years before obtaining his college degree, he continued business while attending college. Throughout his forty-seven years of engineering he has combined with it a patent practice. As inventor and patentee, he stands third or fourth in the whole world. His patents are fundamental, covering the electric railway art (trolley, conduit and accumulator systems); also the transformer system of electrical transmission (both method and means for transmission with reduction of potential as well as the combined "step up" and "step down" system); also electric point welding system. He invented and constructed the first modern moving picture machine (1894) and had the first moving picture exhibition hall in the country. In and following 1874, he was engaged in building iron and steel plants in Ohio, Kentucky and West Virginia and was engineer to Olive Foundry and Machine Works of Ironton, Ohio; Consulting Engineer in Chicago in 1876; organized the Atlantic and Pacific Electric Mfg. Co., 1879 (secretary and director); Globe Mfg. Co., 1885 (director); Hunter Electric Co., 1886-1887 (director); Electric Car Co. of America, 1887 (president); General Electric Automobile Co., 1898 (director); Tractor Truck Co., 1899 (director); The Mirabile Corporation, 1902 (president); U. S. Assay and Bullion Co., 1903 (president). He was also director in Acetylene Light, Heat & Power Co., 1902; Electric Vehicle Equipment Co., 1902; Herr Automatic Press Co., 1906; and others. He organized Hunter Pressed Steel Co., 1914 (owner).

In expert capacity, Mr. Hunter has been

retained by many corporations, among them General Electric Co. (21 years); Victor Talking Machine Co. (17 years); also the Continental Conduit and Cable Co.; Westinghouse Electric & Mfg. Co.; National Cable Railway Co.; United Gas Improvement Co.; Thomson-Houston Electric Co., and numerous others. In 1879-1881, he developed a submarine vessel, in 1882 published an illustrated pamphlet on it, and in 1883 submitted the invention to the British Government. He developed a smokeless powder and made tests for the French Government in 1883-1884; placed before the British Parliament, in May, 1883, his electric railway plans for use in proposed Dover and Calais tunnel; gave demonstrations of his submarine to the Chief of the Torpedo service of Great Britain in 1884, and to members of the United States Congress in 1885. His inventions have been controlled by many corporations, among which are Thomson-Houston Elec. Co.; General Elec. Co., and the Westinghouse Elec. and Mfg. Co., which owned, controlled, or were licensed under about 300 patents; Electric Car Co. of America, about 150 patents; General Electric Automobile Co., about 70 patents; Tractor Truck Co., 8 patents; International Power Co., about 72 patents; and very many other companies and individuals, who have used and are using his patents in many and varied industries. His earliest invention was a machine for making tambour lace in 1868. He regards as the greatest of all his work, that in original research carried on since 1903, relative to the breaking down and reconstruction of atomic matter, including the transmutation of the elements. His work in this direction has been extensively referred to by the press. He describes the results of his work, which have enabled him to transmute one character of atom into another, thus: "This may be done as an instantaneous process, or it may be caused to take place slowly as a "growing" process. The precious metals are more easily produced by transmutation than the baser ones. For example, pure gold may be made commercially at a cost not exceeding about ten percent of the values produced. The process does not set the electrons of the atoms free, but so modifies the control of the electrons within the confines of their atomic structure, that combining of a plurality of atoms to form an atom of a greater atomic weight is possible. This process is rapid when conditions are right. In case of "growing", the process is relatively slow, but is in effect the creation of life to a mineral, giving to it a place analogous to plant and animal life. In other words—I may treat a silver dollar to a process which impresses upon it certain physical conditions, and thereafter, within its mass, gold will "grow" in such quantity that it may be separated by any refining process. At the beginning of the growing phenomena there was no gold, but after a year or so, the richness in gold is very pronounced, and this growing of the atom, gold, when no gold was before present, may continue until 10 to 20 per cent of the mass has been changed".

England's greatest chemist, the late Sir William Ramsay, was in touch with Mr. Hunter in this work, had many samples of the growing gold and made corroborative analyses in respect to some of the tests for Mr. Hunter.

Mr. Hunter is a member of the Manufacturers' Club of Philadelphia, the American Institute of Electrical Engineers (since 1884), the Societe Internationale des Electriciens, Paris (foundation member), and the American Association for the Advancement of Science.

HARVEY HUBBELL

HARVEY HUBBELL

Harvey Hubbell, head of Harvey Hubbell, Inc., of Bridgeport, Conn., has advanced to leading prominence in the manufacture of electrical specialties and machine screws, and this position has been attained by adherence to high standards of quality and uniformity in production. Mr. Hubbell was born in Brooklyn, N. Y., December 20, 1857, and was educated at the Easton Academy, Easton, Conn., Eastman's Business College, Poughkeepsie, N. Y., and at the Cooper Institute, New York City. Having a natural fondness for mechanics, he entered early in life into practical training in the manufacture and designing of printing presses with the Potter Printing Press Works, and with the Cranston Printing Press Works of Norwich, Conn. He was also for a time connected with John Roach & Son, ship and marine engine builders, of New York City and Chester, Pa. In these connections he was thoroughly trained in the art of handling tools and also gained a knowledge of human nature that was of great value to him in the conduct of his own business. At this period, while working hard all day, his desire to thoroughly familiarize himself with every detail of the lines along which he was working, led to the devotion of his evenings to study and drafting, and as a result he became proficient in the theoretical as well as the practical side of his chosen calling. In 1888, he went to Bridgeport, Conn., and started in a small way the manufacture of one or two patented articles of his own invention. This led to the making of tools and machinery, and with his practical training and disposition to study mechanical principles, his attention was directed to the possibilities in the electrical industry. The movement to commercialize the science was then in its infancy, but had advanced far enough to give some idea of its future adaptation to various uses. Mr. Hubbell combined his knowledge with the electrical needs of that period and virtually opened up a new field, keeping pace since with the rapidly developed needs of the industry. As electricity came into more general use for domestic and industrial appliances, Mr. Hubbell diverted his activities in that direction and added many electrical specialities to his line of manufacture. That he has been a prolific worker is shown by the fact that he has taken out over one hundred patents. Among these are the well-known Hubbell Pull Socket and the Hubbell Interchangeable Attachment Plug, which is in almost universal use throughout the country. Many other of his devices of convenience and utility have been leaders in their line. He was the first to make rolled thread machine screws with automatic machinery and a part of the large plant is given over to this department exclusively. The many products of Harvey Hubbell, Inc., are most favorably known in every state of the Union, and in their manufacture the electrical as well as the mechanical requirements have been conscientiously considered, with the result that the Hubbell goods are of the highest type. Mr. Hubbell keeps in personal touch with every branch of the enterprise and in the conduct of the business attends to the engineering work and supervises the manufacture and sale of the many appliances turned out. Mr. Hubbell is the architect of the success of his business and under his fostering care the small and seemingly insignificant undertaking of thirty years ago has grown to large proportion and is now one of Bridgeport's leading industries. The business was incorporated under its present title in 1905.

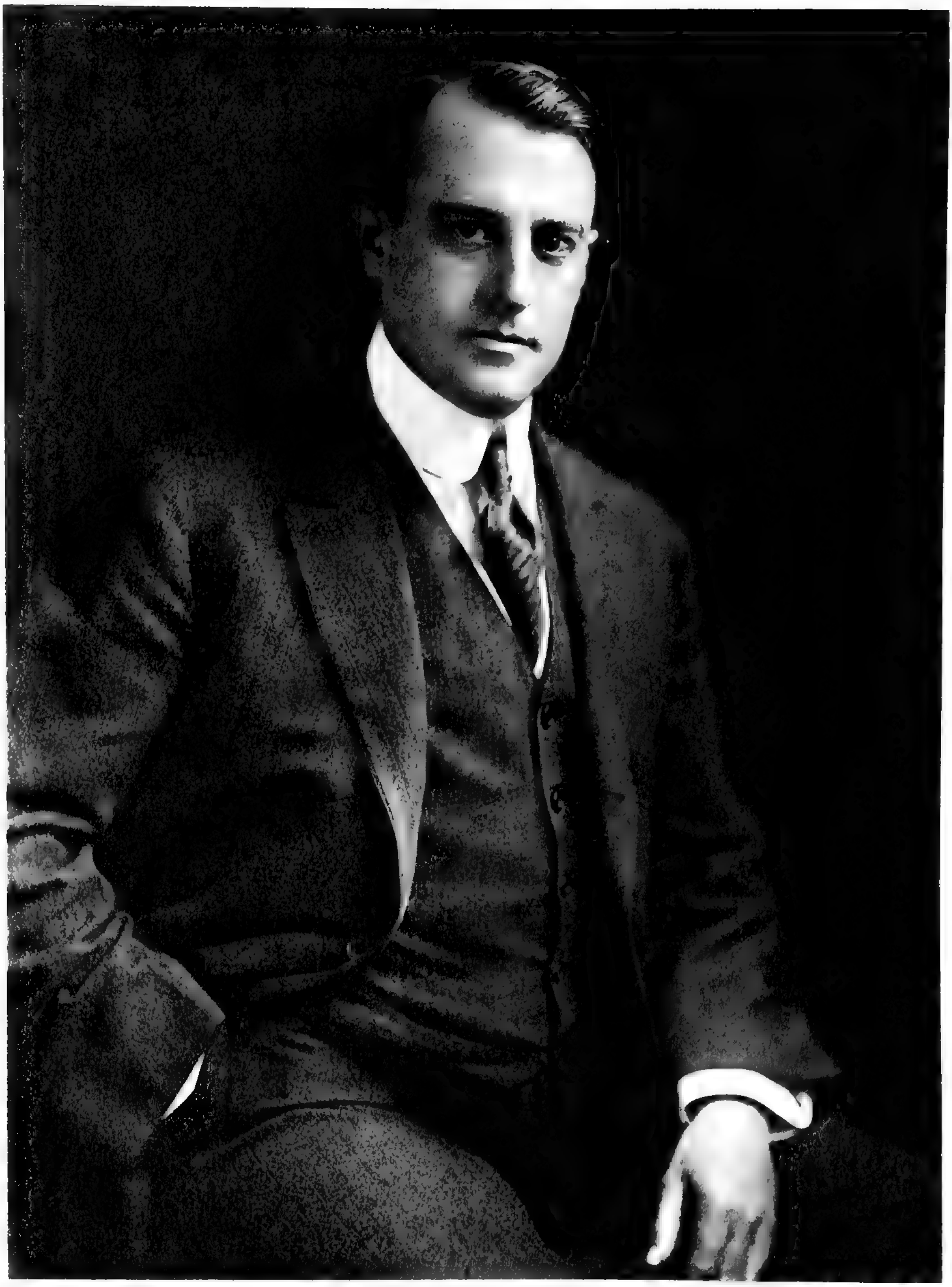
Mr. Hubbell is a member of the Union League Club, Hardware Club, New York Athletic Club and the Electric Manufacturers' Club of New York City; the Automobile Club of America; the Seaside Club, Brooklawn Country Club and the Manufacturers' Club of Bridgeport, Conn.

DR. MILLER REESE HUTCHISON

Dr. Miller Reese Hutchison, late Chief Engineer of the Thomas A. Edison interests, and Engineering Advisor to Mr. Edison, and now President of Miller Reese Hutchison, Inc., Vice-President of the Hutchison Office Specialties Company, and member of the Naval Consulting Board, has a career along electrical lines, beginning with his eleventh year, that fairly teems with incident, activity and great achievement. He is a Southerner, having been born at Montrose, Baldwin County, Alabama—a suburb and summer resort of Mobile—on August 6, 1876. He attended private schools in Mobile, Alabama, from 1883 to 1889, followed by two years at the Marion (Alabama) Military Institute. In 1891, he entered Spring Hill (Alabama) College, where he remained until 1892. During 1893-95, he attended the University Military School of Mobile, and put in a year with his father in the wholesale grain business. He finished his mental training by taking a special course in Electrical and Mechanical Engineering and Design at the Alabama Polytechnic Institute, finishing in 1897. This was followed by a course in anatomical dissection in the Alabama Medical College, in 1897-98. During his preparatory work in private schools, Dr. Hutchison served an apprenticeship in foundry, pattern and machine shops, to get the practical training which proved of inestimable value to him in later years. He was only eleven years of age when he selected his profession. The work of Edison attracted him and, more than any factor, influenced him in the choice of a profession. With Edison's achievements to emulate, he bent every energy to become a worthy follower of that noted scientist. At the age of twelve, he had fully determined to some day become the chief engineer of the Edison Laboratory, and in 1912, twenty-four years later, this desire was gratified.

After finishing his education, Dr. Hutchison became engaged in special aural investigation, in connection with the development of instruments to enable the deaf to hear, which were invented by him in 1895 and which were held in abeyance for perfecting. When the Spanish-American War threatened, his work was interrupted and he was appointed Electrical Engineer of the Seventh and Eighth Districts, U. S. Lighthouse Establishment, and was engaged during the war in laying submarine mines and cables along the Southern coast of our country. When the war ended, he came to New York and established a laboratory on 20th Street, near 4th Ave., New York City, in March, 1899, perfecting his aural instruments, now universally known as the Acousticon, and the equally well known Dictagraph, a modification of the Acousticon. In addition to these wonderful instruments, Dr. Hutchison invented current-limiting devices for street railway cars, and was only a few months behind Frank J. Sprague in the conception of and application for patents on fundamenal principles which have dominated multiple unit control. Several hundred patents have been granted Dr. Hutchison on a wide variety of invention, among which are the Klaxon horn, known wherever automobiles are used; the Hutchison Spool-o-Wire Paper Fastener, in universal use; improvements in alkaline and acid storage batteries; electrical tachometers; road speed governing devices of which the "Pierce" operates under his patents, etc.

Dr. Hutchison possesses a somewhat rare combination of inventor, engineer and business man, to which is attributed the fact that, aside from the fame which his inventions have won, a substantial fortune has also been accumulated. Following his early association with the Government Service, he was Vice-President of the Akouphone Company, 1899-01; Vice-President of the Hutchison Acoustic Company, 1901-04; Consulting Engineer for large interests



MILLER REESE HUTCHISON

in New York, 1905-07; Vice-President and Treasurer of the Hutchison Electric Horn Company, 1905-08; engaged in research work in his own laboratory, 1908-10, and at the same time engaged in the distribution of the Klaxon horn, development work on Edison Storage Batteries, 1910-12; Advertising Manager Edison Storage Battery Company and Chief Engineer to and Personal Representative of Thomas A. Edison in 1911-12. His fidelity and ability were awarded in 1912 by his being made Chief Engineer of the Edison Laboratory, of Thomas A. Edison, Inc., and of the Edison Storage Battery Company. He continued in this relation until January 1, 1917, when he was appointed Engineering Advisor to Thomas A. Edison, and acquired exclusive sales rights of the Edison Storage Battery for all Government purposes. These were assigned to Miller Reese Hutchison, Inc., which he owns in its entirety, and of which he became president. He is, in addition, the Vice-President and majority stockholder of the Hutchison Office Specialties Company, New York, which manufactures and markets his inventions of this character.

Dr. Hutchison is the son of William Peter and Tracie (Magruder) Hutchison. He is of Scotch and French descent, his progenitors being the Perrys, Magruders and Hutchisons who are numbered among the oldest and best known families of this country. He was married in New York City, on May 31st, 1901, to Martha Pomeroy, of Minneapolis, Minnesota, and Jacksonville, Florida, and is the father of four fine boys, Miller Reese, Jr., age 16, Harold Pomeroy, age 14, Juan Ceballos, age 12, and Robley Pomeroy, age 10.

Although Dr. Hutchison's time is fully occupied with scientific, commercial and Government work, he takes great interest in photography and the observation of surgery in hospitals. His achievements have brought honors in national affairs, and many awards and decorations. He was Electrical Engineer of the United States Lighthouse Establishment, 7th and 8th Districts, during the Spanish-American War, and since the organization of the Naval Consulting Board, has been a member and Assistant to the President of same. He was an honorary member of the Department of Electricity, St. Louis Exposition, 1904, and a member of the International Electrical Congress held in the same city during the Exposition. In 1902, he was presented with a special gold medal by Queen Alexandra, as "Reward of Merit for Scientific Investigation and Invention." He was also awarded gold medals and silver medals at the St. Louis Exposition in 1904. The degree of Electrical Engineer was conferred upon him by the Alabama Polytechnic Institute, in 1913, and the degree of Doctor of Philosophy was conferred upon him by the Spring Hill College in 1914, both for conspicuous achievement. Dr. Hutchison is a member of the American Society of Mechanical Engineers, American Institute of Electrical Engineers, Society of Automotive Engineers, American Institute of Radio Engineers, New York Electrical Society, American Society of Naval Engineers, American Institute of Social Sciences, Naval Institute, Navy League, Engineers Club, Machinery Club of New York, and the University Club of Washington, D. C. His winter home is in Llewellyn Park, Orange, New Jersey, and summer home on Lake Minnetonka, Excelsior, Minnesota.

WILLIAM A. HILL

William A. Hill, electrical engineer for the Willys-Overland Co., of Toledo, Ohio, is a native of Toledo, where he was born March 27, 1882. After completing his education in the schools there, making special studies of electrical subjects he became practically identified with electrical work for the F. Bissell Co., of Toledo, manufacturers of switch and control apparatus. From there he went to the Pope Motor Car Co., of Toledo, of which he became electrical engineer, continuing that connection until he assumed his present position as electrical engineer for the Willys-Overland Co., manufacturers of automobiles, with plants at Toledo and Elyria, Ohio.

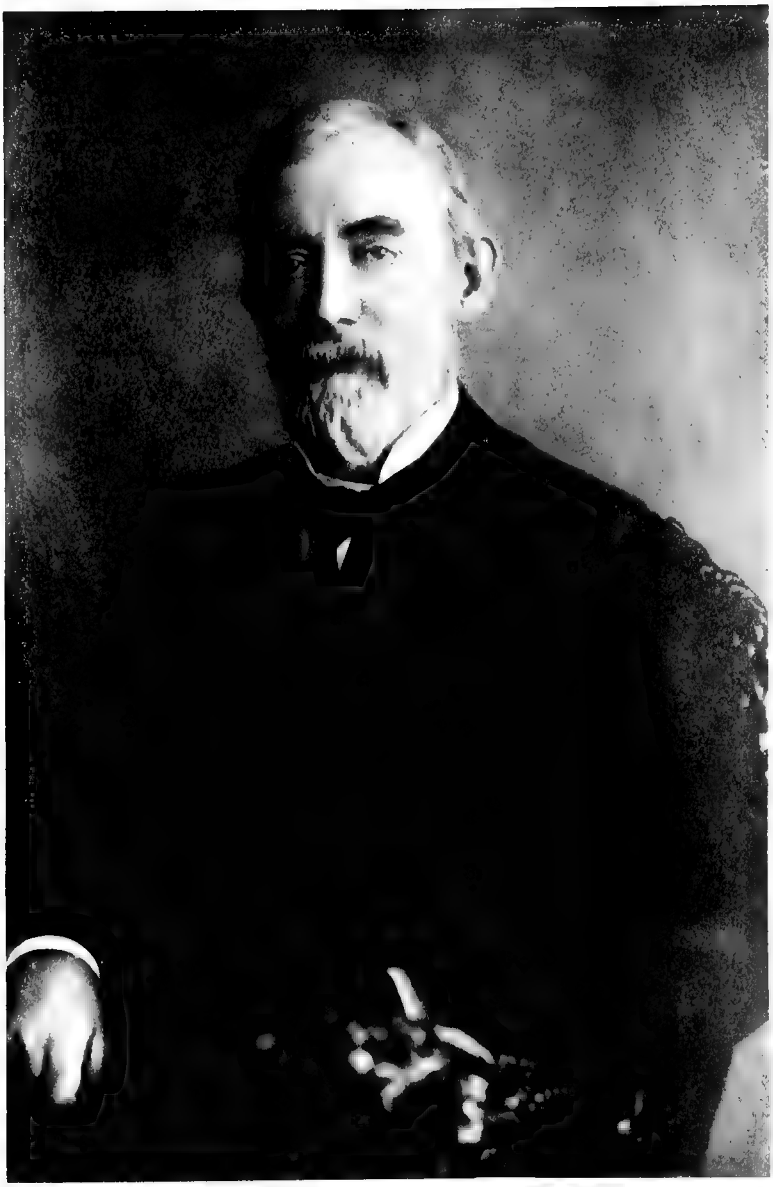
Mr. Hill has made a specialty of testing automobiles and airplane engines by electricity. For this purpose the engine test room of the Willys-Overland Co., of Toledo, has been equipped upon the most elaborate scale for electric testing of auto-

WILLIAM A. HILL

mobile engines, the result of which is a great improvement in efficiency, saving of time and energy and reduction of cost as compared with the old belt system of testing, as in the Toledo test room, 400 engines have been tested in a nine-hour day.

Mr. Hill is also particularly well known as a specialist in the control and application of electricity for industrial heating with special reference to enamelling processes.

He is an associate of the American Institute of Electrical Engineers and was chairman of the Toledo Section in 1918, and is a member of several fraternal societies. Outside of his profession he is particularly interested in farming, the growing of fruits, and the raising of livestock.



JAMES F. HUGHES

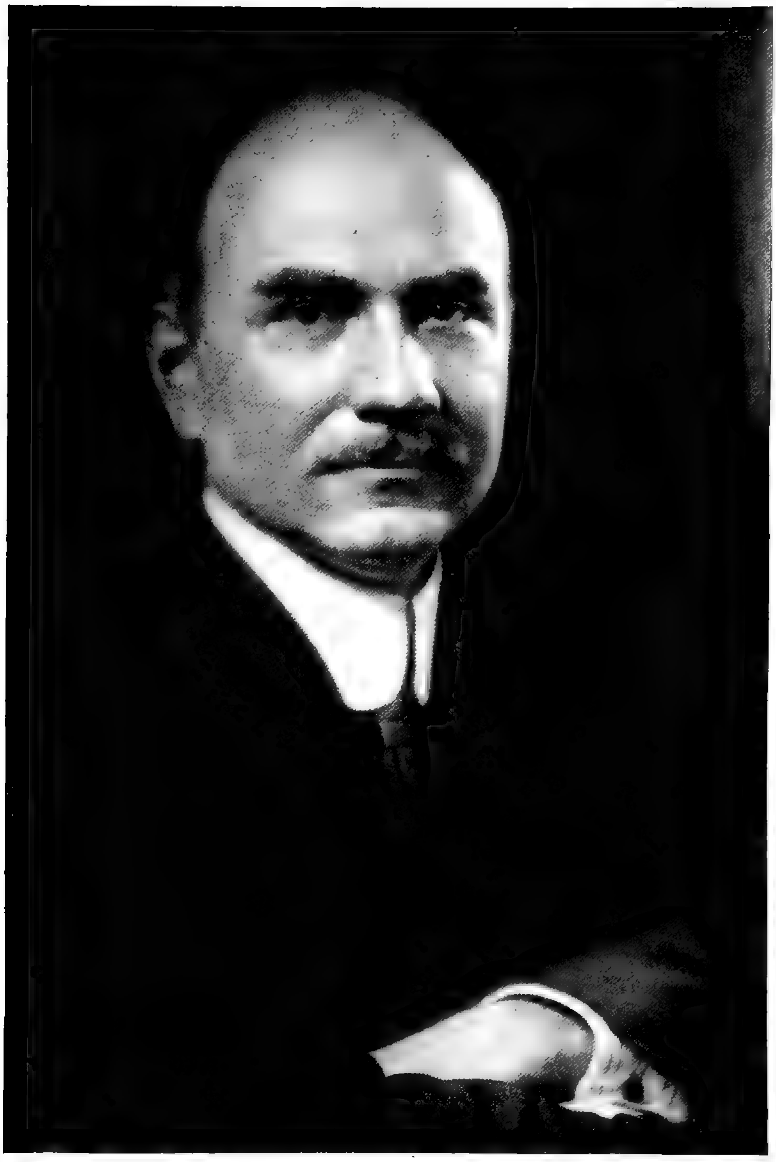
JAMES F. HUGHES

Throughout the period from 1845 down to the present date, the career of James F. Hughes has been one of development of opportunities, interesting alike to his associates and to the younger men in the industry. At the outbreak of the Civil War in 1861 James F. Hughes found himself completing his studies in the high schools of Pittsburgh, and it is to be assumed that he then faced a critical decision and that the current upheavals in the country's life had their influence upon his future. It may explain why he first turned to medicine, serving a year's apprenticeship in the office of Dr. Murdick, a local physician of high standing. There was, however, to be no future Dr. Hughes, for the mysteries of telegraphy were then just becoming understood. One could name a long list of interesting personalities who as young men felt the appeal to imagination found in the telegraph key. Mr. Hughes was one of these. As a first step he mastered the code and set to work as a telegrapher in Outer Depot, Pa., in 1862. Next he is found in the office of Andrew Carnegie when the coming steel king was superintendent of the Western Division of the Pennsylvania Railroad. During the progress of the war he served the Western Union in a managerial capacity at Newark, Ohio, and Fort Wayne, Ind. His character and ambitions were of the caliber that assumes responsibility and gravitates towards leadership. The Western Union might profitably have held on to him, but in 1890 events led to a connection with the New York Edison Company, as downtown agent. Two years later, when the New York Electric Equipment Company was organized to take over the equipment work of the New York Edison Company, Mr. Hughes was engaged as general agent, a position he held until 1900 with the exception of an interval during which he acted as manager of the Metropolitan Electric Equipment Company. With him in the New York Electric Equipment Company were Nathaniel Webb, J. Howard Dilts, Harry E. Bailey and Walter G. Darby. Their association here was productive of pioneering work of historic interest. This company equipped one of the first electrically propelled locomotives in New York City, the experimental trip being made upon the old 34th Street shuttle of the Manhattan Elevated Railroad. In the same connection, many of the city's early electric light and power equipments were the result of Mr. Hughes' endeavors. The present successful firm of James F. Hughes Company, electric contractors, dates from 1901. Mr. Hughes is president and in continued association with him are the above-named gentlemen, who are, in respective order, the vice-presidents, treasurer and secretary. Coincident with the presidency of the James F. Hughes Company, Mr. Hughes has filled the post as treasurer to the Charles A. Borne Company, electrical machinists, New York City. As ideals of service have distinguished his work in the electrical field, so it is characteristic of the man that he should choose to identify himself with an organization of proven social and ethical purpose. Masonry, therefore, has been Mr. Hughes' hobby, indeed, it implies a fuller description, to be had in Ross's History of Masonry. Here, it will indicate enough to mention that among the honored posts he has held in the Order are: Senior Past Master of Metropolitan Lodge, No. 273 of New York; Past High Priest of Ancient Chapter, No. 1, New York; Representative of Grand Chapter of Florida, near the Grand Chapter of New York; Past Commander of Damascus Commandry, No. 58, of Brooklyn, N. Y.

WALTER HOWARD JOHNSON

After a service of over 31 years in aiding the development of Philadelphia's public utilities, Walter H. Johnson has risen to the position of first vice-president of the Philadelphia Electric Company, a giant corporation that furnishes unusually efficient light and power service to the Quaker City and its wealthy and extended suburbs. Mr. Johnson was born in Philadelphia, August 27, 1863, the son of Jesse and Charlotte Grace C. (Duncan) Johnson. The paternal ancestors were early Colonial settlers in Connecticut, and figured in the Revolutionary struggle. The mother's ancestors were of Scotch origin, the American branch being established in Virginia two generations back. Mr. Johnson was educated in the public schools, after which he filled a commercial position, and was in the service of two of the large trunk line railroads entering Philadelphia. He became connected with the Edison Electric Light Co., Nov. 7, 1887, finally becoming its secretary. This company was absorbed by the Pennsylvania Heat, Light & Power Company which, in turn came under the control of the Pennsylvania Manufacturing Light & Power Co., and this corporation was taken over by the Philadelphia Electric Co., upon its organization October 6, 1899, Mr. Johnson becoming a director and vice-president of the new company—a position he still retains.

He is a member of the Pennsylvania Society of the Sons of the Revolution, a life member of the Navy League of the United States, member of the Franklin Institute of Philadelphia, and Engineers Club of New York City. Mr. Johnson is also prominent in Masonic circles, and his home clubs are the Union League, Racquet, Merion Cricket, Philadelphia Country Club, and the Pen and Pencil. He was married October 1, 1888, to Clara Wilson Knepley.



DUGALD C. JACKSON

DUGALD CALEB JACKSON

In the field of applied electricity Professor Dugald Caleb Jackson has earned and holds threefold prominence as engineer, educator and writer.

He was born at Kennett Square, Pennsylvania, February 13, 1865, the son of Professor Josiah Jackson and Mary Detwiler (Price) Jackson. He was graduated from Pennsylvania State College with the degree of B. S. in 1885 and in 1888 received that of C. E. from the same institution, and he pursued graduate studies in electrical engineering at Cornell University from 1885 to 1887, and simultaneously from 1886 to 1887 was instructor in physics at Cornell. He was engaged as vice-president and engineer of the Western Engineering Company, at Lincoln, Nebraska, from 1887 to 1889; became assistant chief engineer of the Sprague Electric Railway and Motor Company, New York, from 1889 to 1890, and in 1890 and 1891 was chief engineer for the Central District of the Edison General Electric Company. In 1891 he entered the faculty of the University of Wisconsin, in which position he continued for sixteen years of remarkable creative work, making his department notable for its excellence in management and efficiency from the standpoint of education. From an institution which had not specialized in electrical education he made the University of Wisconsin known everywhere as having an electrical engineering department of the highest grade and the most able management. So famous had Professor Jackson become as an educator in that branch of technology and a creator of a department of electrical engineering that when, following the resignation of Dr. Louis Duncan, who had been professor of electrical engineering and head of the electrical department of the Massachusetts Institute of Technology, the trustees, after the survey of the educational field, settled on Professor Jackson, who since 1907 has been at the head of the department of electrical engineering in the Massachusetts Institute of Technology. His work in that connection has placed this department in the foremost rank of electrical education in this country and the peer of any in the world, and given to Professor Jackson, personally, the highest prestige as a teacher and trainer of electrical engineers. Nor is his prestige as an educator confined to his work in the building up of the departments of electrical engineering in the two great institutions which have had the advantage of his effective genius for organization and his exceptionally complete equipment as a technical educator. He is also author of text-books in his department which have furnished the educational basis for many in his own and other institutions who are now successfully practising as electricians.

Professor Jackson is a co-patentee with Professors Wm. A. Anthony and Harris J. Ryan of the repulsion motor with closed coil armature, which is now in general use wherever repulsion motors are needed. He is also patentee of the reciprocating motor drive used for actuating planers, shapers and other machine tools; and various other inventions of value.

For more than twenty years he has been senior member of the firm of consulting engineers denominated D. C. & Wm. B. Jackson, who began business with an office at Madison, Wisconsin, while Professor Jackson was at the University of Wisconsin, and who for ten years past have had offices in Chicago and Boston, during which time they have been associated with many of the notable electrical projects of the country and have also served as engineers in foreign countries.

Professor Jackson was called to active service overseas with the rank of Major of the Engineer Reserve, U. S. A. He considered it his duty to respond, which he did at great sacrifice to domestic, business and financial arrangements and the temporary laying down of his duties and obligations at the Massachusetts Institute of Technology.

THEODORE INSLEE JONES

Theodore Inslee Jones, General Sales Agent of the Edison Electric Illuminating Company of Brooklyn, graduated from the Massachusetts Institute of Technology with the degree of Bachelor of Science in the department of Electrical Engineering.

Soon after graduation he entered the telephone field in the New York office of the American Telephone & Telegraph Company, being identified with the Inspection and Executive Departments of the company. While there he organized and equipped the first school of instruction for telephone traffic, writing the first student's book of instruction for handling long distance business. This has since become an important adjunct of all telephone companies' work.

After four years with the American Telephone & Telegraph Co. he became assistant to the superintendent of the New York & New Jersey Telephone Co. in New Jersey, and while there directed the traffic work. During this period he began delivering a course of lectures on electrical topics for the New York Board of Education, which work he has continued up to the present time, including in his courses talks on electrical signalling, electric light, electric power and electric railways.

Leaving the telephone company to enter the electric lighting field, Mr. Jones organized and became the first manager of the sales department of the United States Light and Power Company of New York City. After two years with the United company he was offered and accepted the position of general sales agent of the Brooklyn Edison Co. He reorganized the commercial department of the Brooklyn company, combining the advertising, new wiring, appliance, city, power and lighting bureaus into one large department. An elaborate appliance showroom, known as the Brooklyn Edison shop, was equipped and seven branch offices were established throughout the city.

Mr. Jones has written a number of papers which have been presented before the National Electric Light Association and the Association of Edison Illuminating Companies. Among these may be mentioned: "Functions of a Sales Department," "Development of Revenue from Existing Customers," "Canvassing by Telephone," "Selling Electricity" and "Instrumental Methods of Measuring Maximum Demand."

He was elected Chairman of the Commercial Section of the National Electric Light Association, and served in such capacity during the year 1913-14. He is a Past Statesman of the Jovian Order, member of the American Institute of Electrical Engineers, Illuminating Engineering Society, New York Electrical Society, Kilowatt Club, Brooklyn Chamber of Commerce, Rotary Club of Brooklyn, Technology Club of New York, Engineers Club of New York, Crescent Athletic Club, Engineers Country Club and Richmond County Country Club.

LUDWIG KEMPER

Holland, which in its early days of colonization in America furnished one of the sturdiest and most substantial elements to the citizenship of the country, has in these later days contributed to the engineering profession of this country a number of able and intensively trained men who have attained professional prominence.

One of these, holding an important position among those in control of lighting interests is Ludwig Kemper, President and General Manager of the Spokane Heat, Light and Power Company, of Spokane, Wash.

Mr. Kemper was born in Rotterdam, Holland, September 13, 1877, and after a very thorough elementary and preparatory training he entered the University of Delft, Holland, from which he was graduated as Mechanical Engineer in 1899, following with a two-year post-graduate course leading to graduation as electrical engineer from the Engineering School at Karlsruhe, Germany.

After graduation Mr. Kemper was managing engineer for the Griendtsveen Moss Litter Company, Limited, of Rotterdam, manufacturers of briquettes of peat and other peat products. Coming to this country he became identified with the railway car-building industry, first with the Pullman Company, Chicago, as draftsman, and later as engineer with the George M. Brill enterprise in Chicago. He was also assistant electrical engineer with the Baltimore & Ohio Railroad at Baltimore, Maryland.

He entered the field of gas and electric light service as secretary-treasurer of the Minnesota Gas and Electric Company of Albert Lea, Minnesota, and in that connection he became and still remains deeply interested as a student of the problems of combustion engineering. He became prominently identified with the Minnesota Electric Association, of which he was secretary-treasurer, 1908-1909, and president, 1910-1911 and 1916-1917. He is now consulting engineer for Field, Richards & Co., of Cincinnati, and at the head of the Spokane Heat, Light and Power Company of Spokane, which has a complete modern equipment and a large and increasing business.

He was president of the Business Men's

League and the City and County Hospital at Albert Lea, Minn., and is a member of the Town and Country Club there; of the University and Country Clubs of Spokane; all Masonic bodies, and the Elks.

G. L. KNIGHT

As a designing engineer of central station construction, Mr. G. L. Knight has made his way to distinction through paths of practical experience. He is of New England sea-captain ancestry on both lines of descent, his earliest American ancestor coming over in the Ship *James* in 1635. Born in Haddonfield, N. J., February 20, 1878, he was educated in Philadelphia in the Penn Charter School and the Drexel Institute, whence he was graduated E.E. in 1900. He was president of the Athletic Association and captain of the track team in college.

His first work was with the Philadelphia Electric Company, beginning in June, 1900, in the Operating Department at its first 5500-volt "high-tension" (so called) generating plant in Callowhill Street as dynamo tender and switchboard operator. In 1901 he was wireman for the D'Olier Engineering Company, Philadelphia, and later manager of the switchboard shop of the Walker Electric Company. In 1902 he became surveyor and inspector during the construction of the New York Edison Company's Waterside Station; and in 1903-1905, under George O. Orrok, the company's Mechanical Engineer, Mr. Knight was chief draftsman at that station and had charge of about twenty draftsmen and inspectors laying out and surveying construction work at that station.

In September, 1905, Mr. Knight was appointed to the position of Chief Draftsman of the Brooklyn Edison Company, this appointment placing upon him the duty to organize an Engineering Department. Since 1908 he has been the Designing Engineer of the Company and the head of its Engineering Department. In that capacity he has the direct supervision of all the electrical, mechanical and civil engineering design for the company, and also has charge of building construction, including bulkheads and piers, condensing tunnels, etc., as well as station construction, so that his work has covered a wide field.

He is a fellow of the American Institute of Electrical Engineers, and has been a member of its Standards Committee since 1914; also a member of the American Society of Mechanical Engineers. He is a member of the National Electric Light Association, has been on its Electrical Apparatus Committee since 1911, was secretary 1914-1916, and since then has been chairman of that committee. He is also a member of the New York Electrical Society, the Brooklyn Engineers' Club, of which he was elected President for 1918, and the Crescent Athletic Club of Brooklyn.

LEONARD KEBLER

Leonard Kebler is an electrical engineer specializing on the design and manufacture of electrical controlling devices. He was born in Cincinnati, Ohio, September 26, 1883. In June, 1889, he entered the employ of the Ward Leonard Electric Co., and worked in various departments until September, 1900, when he entered Columbia University, in the class of 1904. In the summers of 1901 and 1902 he worked for the Ward Leonard Electric Co., and after leaving college he became assistant to the general manager. Later he became president of the Ward Leonard Electric Co., which position he still holds. Mr. Kebler is the inventor of a number of electric controlling devices made by his company. He has presented several papers on the electric lighting of automobiles before the Society of Automotive Engineers, and is also author of the chapter on "Rheostats and Resistors" for the Standard Handbook. Besides being president of the Ward Leonard Electric Company, he is president of the Sagamore Development Company and secretary and treasurer of H. Ward Leonard, Inc. He served as Street Commissioner of the village of Bronxville in 1908 and as President of the village in 1912. He is a member of the American Institute of Electrical Engineers, the Society of Automotive Engineers and was chairman of the Metropolitan Section of the latter in the year 1916-1917. He is also a member of the Theta Delta Chi fraternity, Engineers' Club, Columbia University Club, and Scarsdale Golf and Country Club.

HARRY H. KABAT

H. H. KABAT

President, Independent Electric Supply Company

In the fifteen years that have intervened since the establishment of an independent electric supply business, H. H. Kabat, the founder, has labored assiduously to bring success to the venture, which was housed in 1904 in a meagre building at the corner of Broadway and Canal Street. The output has so expanded, through Mr. Kabat's efforts, that it now requires the large eight story building at 59 Warren Street, for stock carrying purposes and twice the floor space could be utilized were it attainable.

Mr. Kabat was born in New York City, October 16, 1877, and was educated in the public schools. At the age of fourteen years he secured a position with James H. Mason, an electrical inventor, and in 1895 he succeeded to the Mason laboratory and gradually drifted into the manufacture of electrical specialties and then entered the construction business as an installation engineer, equipping plants with every known electrical appliance needed for the successful conduct of the manufacturer's business. In 1904 he started his present electric supply house, using in his advertising the slogan "Look out for the Electrical Trust." This brought prominence to the business, which had grown to such proportions in 1910 that it was incorporated as the Independent Electric Supply Company, with Mr. Kabat as president, Mr. Kabat's entire time being devoted to the purchase and sale of goods which range from dynamos to lamps, and the various side lines of small parts and accessories. The Independent Electrical Supply Co. now claims the largest independent mail order electrical supply business in the United States and the territory covers the entire world, shipments being made to remote points in the Far East, all of Europe and South America.

The company are exclusively jobbers and state that no little effort is required to get a stock at a price where that of the dealer handling trust goods can be met. This Mr. Kabat has succeeded in doing and makes the additional claim that he can save the purchaser one third of the cost by buying goods of his house, and for this very practical and economic reason the successful progress of the business has placed it in the position it now holds.

ANDREW KIDD, JR.

Andrew Kidd, Jr., consulting engineer in the application of steam, electrical and mechanical forces, is also well known as a specialist on "Power in Silk Mills." He was born July 17, 1875, in Troy, N. Y., and attended the public schools, the Troy Academy and the Rensselaer Polytechnic Institute in that city. His first active employment was as a draftsman with the General Electric Company, Schenectady, N. Y. He remained with this company fourteen years, filling positions in the drafting, testing, engineering and sales departments, and then began practice on his own account. Just before severing his connection with the General Electric Company, Mr. Kidd held the office of Textile Mill Expert and specialized particularly in power for silk mills, in which branch of work he has continued to a large extent. The present extensive use of individual motors on silk looms is due to Mr. Kidd's past endeavors, as he has made a special study of this character of work and has written several articles on the subject. Mr. Kidd's office address is 95 Liberty Street.

BENJAMIN G. LAMME

BENJAMIN G. LAMME

Mr. Benjamin G. Lamme, Pittsburgh, Chief Engineer, Westinghouse Electric & Mfg. Company and a member of the Naval Consulting Board, was born on a farm near Springfield, Ohio, and was educated in the country schools of that vicinity. Later he entered the Ohio State University and was graduated as mechanical engineer in 1888.

In May, 1889, he entered the Testing Department of the Westinghouse Electric & Mfg. Company, then located on Garrison Way, Pittsburgh, Pa. Soon afterward he took up design work, which he has followed continuously since. In 1900 he was made Assistant Chief Engineer, succeeding to the position of Chief Engineer in 1903, which position he now holds.

Mr. Lamme has been a leader in the developing of alternating current apparatus, including the induction motor, polyphase generators, rotary converters and single-phase railway apparatus. He has also been a pioneer in the development of the earlier direct current apparatus for railway lighting and power work.

As an electrical engineer, Mr. Lamme is known the world over, and he is an exceedingly fertile inventor, having to his credit a very large number of important patents covering electrical apparatus.

One of his duties at the present time is the chairmanship of a commiteee of the Westinghouse Electric & Mfg. Company, which passes on the value and application of various inventions which are brought to the attention of the company.

On recommendation of the American Institute of Electrical Engineers the Secretary of the Navy in 1915 appointed Mr. Lamme a member of the Naval Consulting Board, which appointment was made after a very careful consideration of the entire membership of this organization, numbering over 10,000 and constituting what is one of the largest and most influential engineering societies in the world. In thus conferring this honor upon Mr. Lamme, the Institute has accorded to him the highest possible rank as an engineer and an inventor.

Mr. Lamme was much interested in the adoption of standardization rules by the American Institute of Electrical Engineers and was largely instrumental in formulating those finally adopted.

To attempt to enumerate the achievements of Mr. Lamme in the engineering field would be far beyond the scope of this article. His record and his prominent position with the Westinghouse Electric & Mfg. Company have fully established his position in the engineering field. This company has been foremost in the field of power generation, transmission and utilization for industrial purposes, particularly in the development of railway apparatus in their interurban and steam railway lines.

Several years ago, 22 to be exact, the country was startled by the bold project of harnessing the vast falls of Niagara and distributing electric energy therefrom over a wide range of territory. The electrical design of the 5000 horse-power generators, far bigger than any ever built up to that time, was the individual work of Mr. Lamme. It is a particularly significant fact that, in designing these machines, he had no data or previous machine by which to be guided, as no such generator had ever been built before, and was therefore obliged to rely on his own initiative. The fact that the machines were built from the original design without any change and are now in daily operation after over a score of years of service, speaks volumes for the engineering ability of the designer. This same statement could be made concerning a large number of other pioneer installations throughout the country in which Mr. Lamme has taken a prominent part.

Among the other more prominent installations with which he has been identified may be mentioned the design of the

single-phase motor and generator equipment for the New York, New Haven & Hartford Railroad, the Philadelphia-Paoli electrification of the Pennsylvania Railroad, electrification of the Norfolk & Western Railroad and numerous other installations of importance.

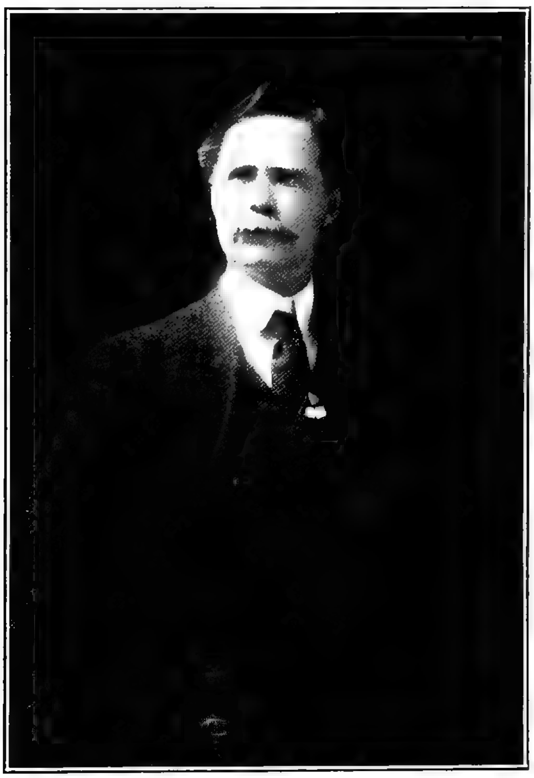
His writings are noted for their clearness and freedom from mathematical complications. Some of his papers read before engineering societies are regarded as classics in their line, especially one read before the National Electric Light Association in 1897. This, after 20 years, is regarded as an up-to-date work on the characteristics of induction motors.

Mr. Lamme has acted for some time past as chairman of the Board of Editors of the Electric Journal.

The subject of this sketch is especially interested in the training of young engineers and takes a particular delight in discovering young men gifted along the lines in which he himself has been successful and further placing them where they can make the most of their abilities.

RICHARD LAMB

Richard Lamb, 90 West Street, New York, was born in Norfolk, Va., Septem-



RICHARD LAMB

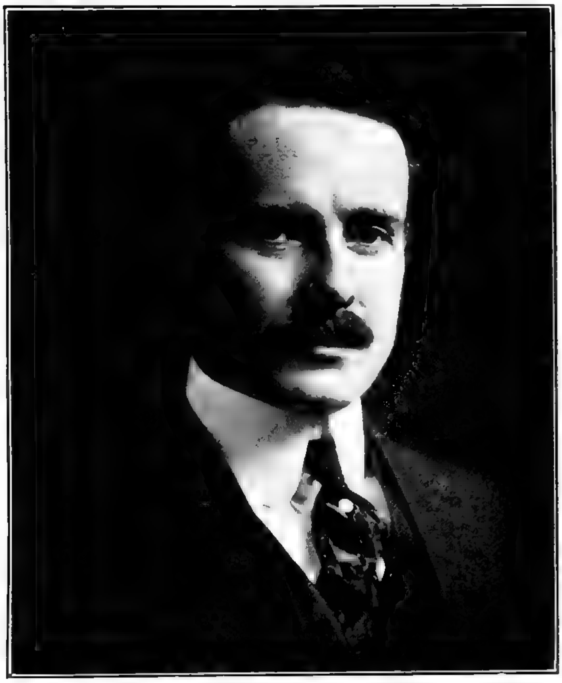
ber 15, 1859. He received his education at Brown University. He invented the electric cableway used for canal boat towing, logging and material handling, in which the motors get their tractional friction independent of their weight. The first large entirely enclosed electric motor was used in this system. See proceedings American Institute Electrical Engineers, October 27, 1897. He invented the chemico-electrolytic process for extracting copper from siliceous ores. See proceedings American Institute Mining Engineers, April, 1915. As chief engineer of Birmingham Water, Light and Power Co., he designed the 63′ high dam as built on the Black Warrior River, Alabama, to take the place of three 21′ high dams. See U. S. Engineers' Report, June, 1911. He has had a large and varied experience in designing and building railroads, trolley lines, material handling and mine plants, streets, roads, sewers, water works, waterways, canals and docks.

He is a member of the American Institute Electrical Engineers, American Society Civil Engineers, American Institute Mining Engineers, American Road Builders' Association, American Society Municipal Improvements.

He designed and built the first large electrically operated coal-handling plant in the metropolitan district, and the first large electrically operated single-phase A.C. bridge traveling crane.

HARRY N. LATEY

Harry N. Latey, who finished his electrical engineering studies with the student's course of the Westinghouse Electric and Manufacturing Co. at Pittsburgh, was born in Omaha, Neb., and received his preparatory training at the Smith Academy, St. Louis. He afterwards took an electrical engineering course at the Massachusetts Institute of Technology, graduating in 1893. He was engineer at the St. Louis office of the Westinghouse Company from 1894 until 1898; assistant engineer of the Manhattan Elevated Railway, New York, in 1898-1900; principal assistant engineer of the Interborough Rapid Transit Co., 1900 until 1904, during which time he had charge of the electrical installation of the first New York subways. He was electrical engineer with the same company, from 1904 until 1906, and from 1906 until 1912 was in private practice as a member of the firm of Latey & Slater, Inc., consulting engineers. Since 1912 he has been connected with the General Electric Co. While in private practice, he was consulting engineer for the Rapid Transit Subway Commission, Public Service Commission, First Division, and the Joint Conservation Committee of New York State. He is a Fellow of the American Institute of Electrical Engineers, a member of the American Society of Civil Engineers, New York Railroad Club, Engineers' Club, Railroad Club of New York, Phi Gamma Delta Club, Technology Club of New York and the Scarsdale Golf and Country Club.



HARRY N. LATEY

IRVING LANGMUIR

Dr. Irving Langmuir, of the Research Laboratory of the General Electric Company, was born in Brooklyn, N. Y., January 31, 1881, son of Charles Langmuir, born in Canada of Scotch descent, and Sadie (Comings) Langmuir, born in Ohio, of Mayflower descent. He was graduated Metallurgical Engineer from Columbia University in 1903, was at the University of Göttingen, 1903-1906 (degree of Ph.D.), and was instructor in Chemistry, Stevens Institute of Technology, 1906-1909. Since then he has been assistant to Dr. Whitney in the Research Department of the General Electric Company. Among his larger achievements have been investigations of the principles of thermionic emission in high vacua; heat conduction in

IRVING LANGMUIR

gases; chemical reactions at low pressures (for which he was awarded the W. H. Nichols Medal in 1915), absorption and surface tension phenomena, structure of liquid films; and other molecular and atomic properties, which have found application in the Coolidge X-ray tube, the pliotron and kenotron, the nitrogen-filled lamp, and the high vacuum mercury-vapor pump. He is author of many important papers contributed to technical journals and the transactions of technical societies. He is a member of the National Academy of Sciences, American Academy of Arts and Sciences, American Chemical Society, American Electrochemical Society, American Physical Society and American Institute of Radio Engineers.

ALEXANDER S. LANGSDORF

Both from the professional and educational sides, Professor Alexander S. Langsdorf, of Washington University, St. Louis, holds a place of distinctive prominence in the electrical world. He was born in St. Louis, August 31, 1877, was graduated from St. Louis High School, 1894, from Washington University (School of Engineering) B. S., 1898; was instructor in electrical engineering there, 1898-1900; then was graduate student at Cornell University, receiving the M. M. E. degree, 1901. He was assistant professor of electrical engineering in Washington University, 1901-1904, and since then has been professor of electrical engineering there, and since 1910, dean of the Schools of Engineering and Architecture.

Endowed with natural inclination toward research and experiment in the field of applied physics, Mr. Langsdorf, from the close of his junior year at Washington University has spent most of his summers in practical work, and in expert and testing work. During the summers of 1897 and 1898 he was in the shop and office of the Emerson Electrical Manufacturing Company; the summer of 1900 with Bryan & Humphrey, consulting engineers, in charge of acceptance tests of the International Light and Power Company, at El Paso, Texas; the summer of 1901 with the General Electric Company, in the Testing Department of its Schenectady (N. Y.) plant, and other summers with other companies in professional consulting capacities of various kinds, with a summer course with the Westinghouse Electric and Manufacturing Company in 1917.

He was a member of the International Jury of Awards (Electrical Section) of the Louisiana Purchase Exposition at St. Louis, 1904; and acted as chairman of the Committee on Terminal Railway Electrification of the Civic League of St. Louis, reporting in 1911.

Dean Langsdorf is a member of the American Institute of Electrical Engineers, the Society for the Promotion of Engineering Education, the Faculty Club of Washington University, the Engineers Club of St. Louis, the Academy of Science, St. Louis; Fellow of the American Association for the Advancement of Science, and member of Sigma Xi. He is a member of the City Plan Commission of St. Louis, City Club, and Town and Gown Club.

H. WARD LEONARD
(DECEASED)

H. WARD LEONARD

The late H. Ward Leonard was a striking example of that limited and fortunate class of professional men who, having decided in their youth their life career, consistently follow the logical steps which lead to success and achievement. Although Mr. Leonard was called to his rest in the height of his powers and in the prime of life, he leaves behind him an enviable record of accomplishments in the electrical industry, many of them distinctly pioneer in character. In this connection it is worthy of note that a year and a half after Mr. Leonard's death a number of the large electrical manufacturing companies acknowledged the validity of sixty odd patents belonging to him. These related chiefly to methods of control in various kinds of apparatus.

H. Ward Leonard was born in Cincinnati, Ohio, February 8, 1861, and died suddenly while attending the annual dinner of the American Institute of Electrical Engineers at the Hotel Astor, New York City, February 18, 1915. He came from a long line of American ancestors, three of his forebears having lived in this country prior to 1639. Mr. Leonard married in 1895 Miss Carolyn Good, of New York City, who survives him.

Having decided to make electrical engineering his life work, Mr. Leonard entered the Massachusetts Institute of Technology, at Boston, and was graduated with the class of 1883. Within a year of leaving college he was associated with Thomas A. Edison as one of four engineers selected by Mr. Edison as a personal staff to introduce the Edison central station system. At the age of 26 he was made general superintendent of the Western Electric Light Company, of Chicago. A year later he became senior member of the firm of Leonard & Izard, of Chicago, a concern which installed many central station plants and electric railways in all parts of the United States. The Edison interests bought out this firm, in 1889, and Mr. Leonard was appointed general manager of the light and power departments of the combined Edison interests for the United States and Canada with headquarters in New York. In 1891 Mr. Leonard resigned this position to establish his own manufacturing business which still operates as the Ward Leonard Electric Company, at Bronxville, N. Y. By 1900 Mr. Leonard had so organized his company that he was able to leave the detailed management of it to others and devote himself principally to experimental work and to the development of his many inventions.

Mr. Leonard's first important inventive work was electric lighting for railway trains, which in 1888 he put into commercial operation by installing his system on two trains running between Chicago and Minneapolis.

In 1891, he completed his inventions of the Ward Leonard System of Motor Control. By this system it is possible to secure a smooth speed control and to almost instantaneously reverse the motor speed from maximum in one direction to full speed in the opposite direction and to reduce to the lowest practicable limit the amount of energy required when starting, reversing and stopping. These results he obtained by an entirely original method of using electric energy. One year after inventing this system Mr. Leonard demonstrated its practicability and value to the Otis Elevator Company and that well-known corporation at once paid the inventor a large price for the right to use it in elevator installation.

In 1892, Mr. Leonard gave to the world his Multiple Voltage System, which was designed for operating motors and electric lights in factories, so that the motors in large plants could be economically operated at any desired speed. This system has been successfully applied in many large industrial plants throughout the world.

Another of Mr. Leonard's important inventions was the "Ward Leonard Double Arm Circuit Breaker" which has come into almost universal use.

The value of the Ward Leonard System

of Control, was demonstrated in battle during the Spanish-American war, where it was used upon the "Brooklyn."

Theodore Roosevelt was then Assistant Secretary of War and in his presence the U. S. Battleship "Brooklyn" was thoroughly tested with one turret operated by the old method and one by the Ward Leonard system, which resulted in the general adoption of the Ward Leonard system in the U. S. Navy. The superiority of the Ward Leonard control was shown when the "Brooklyn" was in battle. A turret equipped with the Ward Leonard system can be so accurately controlled that a shot fired at an object 2,000 yards away can be moved only two inches in either direction.

In 1894, soon after perfecting his system of control, Mr. Leonard visited Manchester, England, and met the builders of reversible steam engines used in rolling mills. The steam engines being used were so limited as to power that they restricted the mills' output. Not only were they deficient in power, but their reversal, so necessary to rolling mill operation, was slow and incapable of speed increase; depreciation was high, and break-downs were frequent.

At that time Mr. Leonard did not succeed in convincing the engineers that his system was advantageous, but to-day nearly every modern rolling mill throughout the world is operated by the Ward Leonard system. Recent exhaustive tests in Germany show that the electrification of the rolling mills by the Ward Leonard system has resulted in a saving of about 15 per cent. in the cost of rolling steel, which in the aggregate makes a saving of tens of millions of dollars annually in that country alone.

In 1910, Lord Justice Fletcher Moulton, in handing down the decision of the highest court of England in a patent litigation in which Mr. Leonard's invention was involved, said, after reciting the difficulty of the reversible rolling mill problem: "Ward Leonard met this difficulty in a very ingenious way," and describing Mr. Leonard's invention said: "It is no doubt a triumph on which electric engineering may well congratulate itself."

The system has also been extensively applied to mine hoists and by its use a speed of 4,000 feet a minute has been safely achieved. This is double the speed under the old system of operation and in addition increased power and greater handling capacity has been secured.

In 1895 the Heilmann locomotive was equipped with the Ward Leonard system. Instead of using the power directly, electric motors were employed and this electric transmission of power did away with the rigidity that is so noticeable in ordinary locomotives. In this equipment any prime mover is used for generating the necessary electricity. Both in this country and abroad this so-called gasoline-electric type of railway traction is rapidly increasing, which shows the increasing recognition of the superiority of electricity as a motive power.

Mr. Leonard's system of "Regenerative Braking" is a very important factor in railroad operations. By this system a train can be stopped more quickly than by air brakes and while being stopped generates electricity which is restored to the plant. It also effects an important saving by doing away with flat wheels and the wear on brake shoes.

This system is particularly valuable in mountain regions where heavy grades exist and by its use the expensive cuts in mountains to eliminate these grades are not necessary. By this system a train going down a heavy grade can raise one coming up to the extent of 60 per cent. of the needed energy, the power house furnishing the other 40 per cent. The road is usually equipped with an overhead wire supplying single phase alternating current and transformed on the locomotive according to the Ward Leonard system.

The Swiss engineers were the first ones to fully appreciate the value of the Ward Leonard Single Phase Railway system. It was early in 1902 that the Oerlikon Co., the leading electrical concern of Switzerland, secured a license under Mr. Leonard's patents and proceeded to build the Ward Leonard-Oerlikon locomotive, which was soon thereafter successfully operated upon the State Railways of Switzerland. This was the beginning of the commercial development of the well-known single phase railway system which now is recognized as the best form of trunk line electrification and is being in-

stalled comprehensively for railway electrification in all of the leading countries.

One of the latest important applications of the Ward Leonard system is to Trans-Atlantic steamers and war ships. Its value can be readily seen. Turbines cannot be reversed and an intermediate gear must be used. The manœuvering of a large ship is necessarily somewhat slow and clumsy. In warfare much depends on the quick movement of the ships. They should be directly and accurately manœuvered by the commanding officer and this cannot be done with the usual equipment, but a turbine can be used to great advantage in generating electricity by which a suitable system of electric propulsion can be operated. By the use of the Ward Leonard system, the captain in the conning tower is absolute master of the situation—he would not have to transmit orders because he unaided and alone can control the operation of the ship without any appreciable effort.

Mr. Leonard's system of electric train lighting, one of his first inventions, was recently modified by him so as to adapt it to automobile use, several recent inventions combining to make the Ward Leonard Dynamo Lighting system the simplest, smallest, lightest and most efficient now in use.

Another of his inventions applicable to automobiles is the form of change gear which is now used in nine out of every ten high grade motor cars and is considered the best in use.

Still another very important invention of Mr. Leonard's is the "Compound Controller" for the control of electric motors operating machine tools. This type of controller is in universal use and the question of priority of inventions was settled in Mr. Leonard's favor only after a long series of contests in the Patent Office with several different inventors of the leading electrical companies.

Mr. Leonard has been a contributor to many technical papers and has delivered a number of addresses to scientific bodies. In June, 1892, he lectured before the American Institute of Electrical Engineers on "A New System of Electric Propulsion," and in February, 1894, before the same body on "How Shall We Operate an Electric Railway Extending One Hunderd Miles from the Power Station?" This was followed in November, 1896, by "Volts vs. Ohms; Speed Regulation of Electric Motors," and in November, 1902, by "Multiple Unit, Voltage Speed Control for Trunk Line Service."

His contributions to the technical press have included "How Can We Haul by Electric Locomotives Freight Trains Weighing Twice as Much as Those Now Hauled by Steam Locomotives?" "Why Steam Locomotives Must Be Replaced by Electric Locomotives for the Heaviest Freight Service" and the "Electrification of Steam Railroads." All of these subjects were exhaustively treated by Mr. Leonard, who showed conclusively that the limit of the steam locomotive had been reached while there was no reasonable limit to the power which can be applied to a freight train by a multiple of electric locomotives under simultaneous control by one operator.

For work along electrical research, the Franklin Institute of Philadelphia, in 1903, conferred upon Mr. Leonard the John Scott Medal while he also was awarded the Gold Medal at the Paris Exposition in 1900 and at the St. Louis Exposition in 1904.

One of the connections he prized highly was his membership in the Inventors' Guild. The society is fashioned somewhat after the French Academy, and none but men who have become noted through important inventive achievement are eligible. In 1913 he was unanimously elected president of the Inventors' Guild.

He had been vice president and also a manager of the American Institute of Electrical Engineers of which he was a member since 1887. He was a member of many social organizations, including the Union League Club of New York, the Inventors' Guild, the Engineers Club, the Clove Valley Rod and Gun Club, the New York Electrical Society, the Technology Club of N. Y., and the Scarsdale Golf Club. He was a director of the Mount Morris Bank of New York, president of the Sagamore Development Company and had been president of the village of Bronxville, where he resided in Lawrence Park.

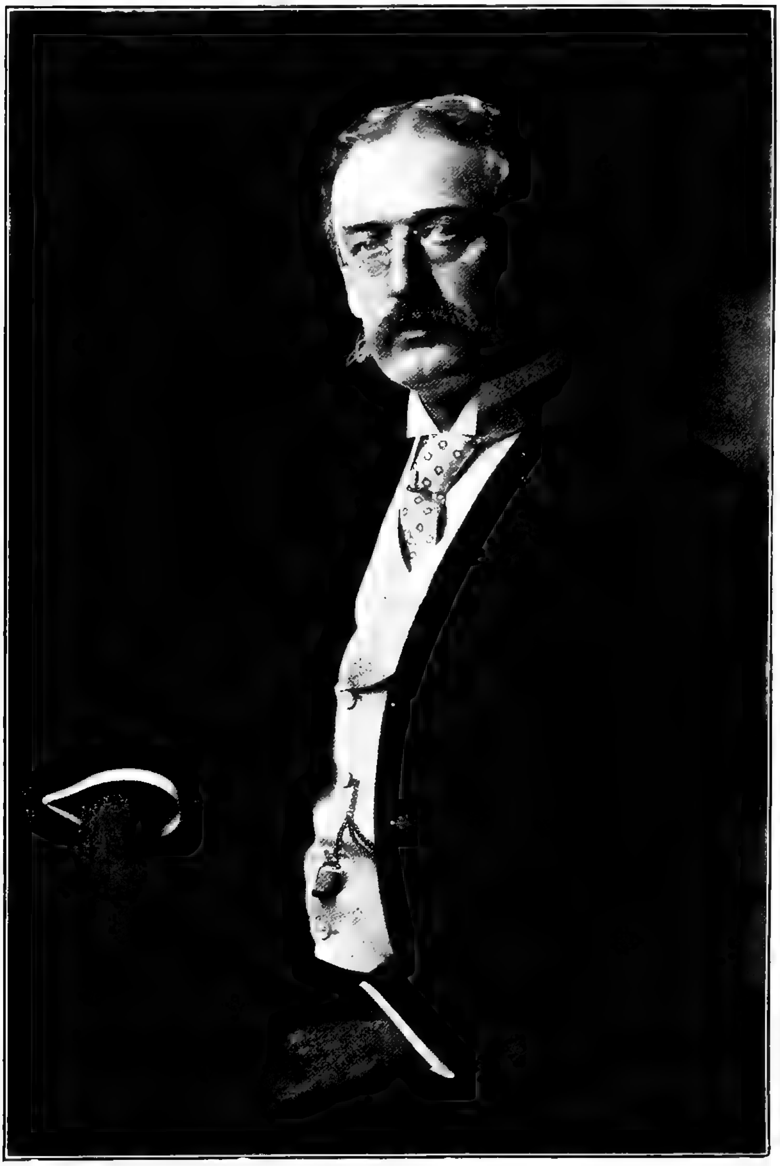
GEORGE B. LELAND

Since June, 1917, George B. Leland has been general manager of The Stamford Gas & Electric Co., a position led up to through several successive stages of experience. The wholehearted and often disinterested service that he has given to his profession has made his name familiar to the fraternity at large and in particular to the lighting division of the industry. He has been especially noted for his work in New England as well as in Connecticut, having been zealous in promoting the welfare of the New England Section of the National Electric Light Association, in addition to his strictly professional duties. He was president of the Section in 1919-1920. Mr. Leland was born at Johnson, Vt., Dec. 14, 1870, receiving his education at common and normal schools. Lacking the means and opportunity to continue his schooling in the technique of electrical practice, to which subject he was drawn, he devoted himself to home study to gain the equipment for a practical career, meanwhile filling a position as engineer at the Connecticut Industrial School for Girls. This was at Middleton, Conn., where he later entered the employ of the local electric light company. Then followed an engagement with the Queen's Borough Electric Light Co. of Far Rockaway, N. Y., and a subsequent period spent with the Norwich Gas and Electric Company of Norwich, Conn. Mr. Leland has held office as Chairman in the Connecticut

Electric Light Association and the Connecticut Get Together Club of N. E. L. A., besides being a member of the Engineers' Club of Boston, Mass. He is active in the Suburban Club of Stamford, Conn., is a 32d degree Mason and an Odd Fellow. In his spare hours, which must be few, he is fond of making excursions into the field of amateur photography. Mr. Leland's home is at Stamford, Conn., where as noted above he is in charge of the Gas & Electric Lighting Co. of that City.

EDWARD A. LESLIE
(Deceased)

As the first important commercial application of electricity was in connection with telegraphy, it followed as a natural sequence that when invention and development created newer and greater applications of electricity the pioneers of success in these should be largely drawn from the ranks of distinguished telegraphers. Among these the late Edward A. Leslie was a well-known and prominent example of those who, having made their mark in the telegraph field, later became executives of ability and distinction in the electric light industry. He was born in Harrisburg, Pennsylvania, in 1849, but in early boyhood removed to Illinois, and in that State made an early entrance into the telegraph business as a messenger boy in the service of the Illinois and Mississippi Telegraph Company at its Freeport (Illinois) office. In those days the telegraph business of the country was split up between numerous companies, each owning rights for certain States or parts of States. The Illinois and Mississippi Telegraph Company was one of those afterward acquired by the Western Union Telegraph Company. His early service was interrupted by his enlistment as a drummer boy, at the age of sixteen, when he joined the Union Army in that capacity with Company E of the Forty-sixth regiment of Illinois Infantry, and with that regiment participated in the siege of Mobile, Alabama. After he had acquired proficiency in the art of telegraphy he was made manager of the telegraph office at Lena, Illinois. The expert operator of those days did not, in many cases, stay long in the smaller towns. As vacancies occurred Leslie was sent to supply them until finally he arrived in New York in the service of the Western Union Telegraph Company. He had not been there long when he was placed in charge of the cable department for that company, filling that important position with faithfulness and high efficiency. In 1882, Mr. Leslie received appointment as superintendent of the Mutual Union Telegraph Company, with headquarters in Washington, D. C., and in 1883 was appointed assistant general superintendent of the Postal Telegraph Company. A year later he was appointed superintendent of the National Telegraph Company, which was a part of the Baltimore & Ohio system, and at the same time he was designated as superintendent of the Eastern Division of the Baltimore & Ohio Company, comprising the Eastern States, and portions of New York, New Jersey, Pennsylvania and Delaware. His excellent service in this capacity won the recognition of promotion, on October 1, 1885, to general superintendent of the Eastern Division, with headquarters in New York. By that time the electric light and other electrical inventions had reached a position of commercial importance and Mr. Leslie became interested in these developments. He was, for a short period, with a storage battery company, and afterwards entered the employ of the Consolidated Telegraph and Electrical Subway Company. In 1888 he was made manager of the Manhattan Electric Company, which was afterward consolidated with the New York Edison Company, and remained with the latter company until 1901. As had been the case with telegraphy, so now with the electric light service. Mr. Leslie became known in electric service for his thorough technical and practical mastery of the business, and applying to it executive ability of a superior order. In 1901 he became general manager of the King's County Electric Light and Power Company, at its headquarters on Pearl Street in Brooklyn. To this important post he brought ability and genius which made him a leading factor in the



EDWARD A. LESLIE

development of that large and important electrical enterprise. He remained in that position until his death on June 5, 1905. Besides the rewards that come from duty faithfully, fearlessly and efficiently performed, Mr. Leslie gained those that are attained through a genial personality. Mr. Leslie, throughout his business life, made friends of his business associates as well as of those with whom he mingled in social life. Many of his friendships were among the veterans in telegraphy with whom he had been associated in the sixties and seventies, as well as those who in later decades became known as leaders in other electrical activities. Others were his comrades from Civil War times, he being a member of the Grant Post, Grand Army of the Republic, of Brooklyn. He was a member of the Crescent Athletic Club and the Hamilton Club of Brooklyn, and was vice-president of the Brooklyn Whist Club, in which he took a deep interest. He was also prominent in Masonry, being a member of the Anglo-Saxon Lodge, and of the Kismet Temple, Nobles of the Mystic Shrine. He married Miss M. E. Morley, who survives him, with their son, Edward Leslie, Junior, and their daughter, Miss Florence M. Leslie.

PAUL M. LINCOLN

The present position and past achievements of Paul Martyn Lincoln give him a place of distinction in the profession of electrical engineering. He was born in Norwood, Michigan, January 1, 1870, was graduated from the public schools and for one year, 1888-1889 he pursued the freshman year studies in the Adelbert College of the Western Reserve University. From there he went in 1889 to take up technical studies at the Ohio State University, where he worked hard in class and laboratory for two and a half years, leaving at the end of the first term of the senior year to take a position which had been offered him by the Short Electric Company of Cleveland, Ohio. He was, however, under a special arrangement with the faculty of the State University, permitted to take examination in his college work from time to time, and was by that means enabled to graduate regularly with his class in the summer of 1892, and receiving the degree of E.E. from Ohio State University.

In the prosecution of his technical studies Mr. Lincoln brought to them the advantage of a natural inclination toward engineering. The year of his graduation was a period when the opportunities for those who were prepared for the electrical profession were very attractive. The advantages of electricity as a source of light were making a strong impression upon industrialists and the public, and the demand for installations taxed the capacity of all the firms and companies in the business. Mr. Lincoln's service with the Short Electric Company extended from January to December, 1892, and he was engaged during that period in experimental work.

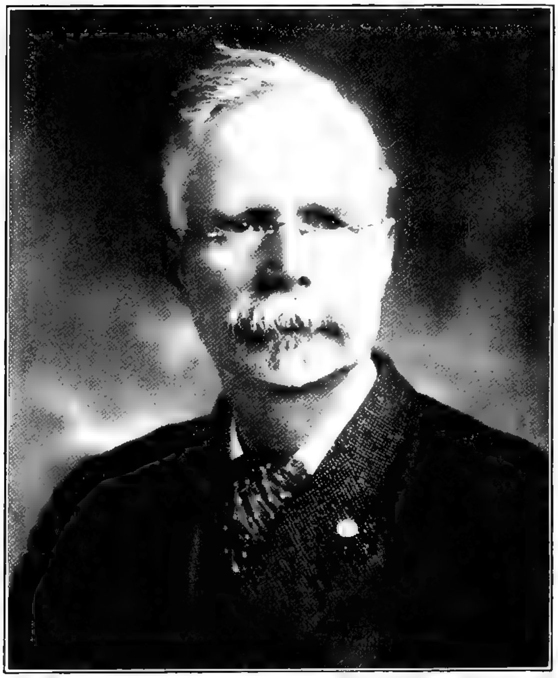
In December, 1892, he went with the Westinghouse Electric and Manufacturing Company, and there he was connected with various branches of electrical engineering, and worked with especial zeal toward the mastery of problems connected with the generation and distribution of the electric current for light and power service. It was this specialization which gave him peculiar fitness for the position to which he was called in May, 1895, by the Niagara Falls Power Company to supervise their electrical installations. It was a very important work and was efficiently executed, the plant beginning to supply current commercially later in the same year. The extensions of this service kept Mr. Lincoln busy for seven years. He did not abandon the field of experiment, however, and it was while he was connected with the Niagara Falls Power Company that he worked out his best known invention, the Lincoln Synchronizer. This is an instrument designed for the purpose of making easier the paralleling of alternating current generators. It was a notable improvement toward the stabilizing of electric service, was awarded a bronze medal at the Buffalo Electrical Exhibition in 1901, and in 1902 it received the John Scott medal of the Franklin Institute of Philadelphia. His work at Niagara Falls was a valuable experience in the practical construction and operation of a large-scale production and transmission of electric light and power, in the development of which he had an important and constructive participation. Mr. Lincoln returned to the Westinghouse Electric and Manufacturing Company as engineer of the Power Department in 1902, and has since continued with that company in several responsible engineering capacities, now (1918) being commercial engineer for the company. He has served as a member of the Publishing Committee of the Electric Journal and has published many contributions on electrical subjects in technical journals and in the proceedings of engineering societies. He is at the present time much interested in studies of the evaluation of electric service for rate-making purposes. He is director of the Department of Engineering in the University of Pittsburgh, and is an enthusiastic supporter of all measures for the advancement of the electrical engineering profession.

He is a fellow and was president, 1914-1915, of the American Institute of Electrical Engineers, member of the American Society of Mechanical Engineers, the Franklin Institute of Philadelphia, the Society for the Promotion of Engineering Education, the American Electrochemical Society, the Engineering Society of Western Pennsylvania, the Engineers' Club of New York and the Pittsburgh Athletic Association, and a fellow of the American Association for the Advancement of Science.

Although still a young man, Mr. Lincoln has seen and participated in an advance in electrical knowledge and an expansion of electric service which is one of the most marvelous chapters of the history of invention and industry. He has made his way to the front rank by hard work and by attacking technical problems in a scientific spirit which compels mastery.

HERMANN LEMP

Hermann Lemp, born in Bern, Switzerland, August 8, 1862, was educated there and at Zurich, Burgdorf and Neuchatel, graduating in 1878, and then becoming student electrician in Mathias Hipp's works, Neuchatel, makers of electric clocks



HERMANN LEMP

and precision instruments. Edison's memorable exhibit at the first electrical exhibition in Paris in 1881 led him to come to America and successfully seek employment in Edison's Laboratory, where he spent a year.

He was afterward associated with Merle J. Wightman in development of the series incandescent lamp system of the Schuyler Electric Company, Hartford, Conn.; became assistant to Professor Elihu Thomson in his laboratory at Lynn, Mass.; chief engineer of the Thomson Electric Welding Company, 1889; and since 1896 has been connected with the General Electric Company; was sent abroad in 1911 to study Diesel engines, and on his return was transferred to the Erie works to assist in the development of high-compression, oil-engined electric lighting sets. Alone or with others, he has taken out more than 300 patents, many of them basic. He is a fellow of the American Institute of Electrical Engineers and distinguished in the profession.

ARTHUR B. LISLE

Rhode Island and Connecticut electric power men have long and favorably known Arthur B. Lisle, who is General Manager of the Narragansett Electric Lighting Company and the Westerly Light & Power Company, and President of the Central Connecticut Power and Light Company; treasurer of the Putnam Light & Power Co.; the West Gloucester Light & Power Company; and the East Providence Water Company. Mr. Lisle entered the profession via the Narragansett Electric Lighting Co., of Providence, R. I., which he joined in July, 1893. In that city he was educated, but was born at West Newton, Mass., December 26, 1871. He is an Associate Member of the American Institute of Electrical Engineers and of the National Electric Light Association, of whose New England Section he is Past-President.

THOMAS D LOCKWOOD

THOMAS DIXON LOCKWOOD

Thomas Dixon Lockwood, long distinguished in the American art of telephony, and an electrical expert and inventor of typical persistence, tenacity and versatility, was born at Smethwick, Staffordshire, a suburb of Birmingham, England, December 30, 1848, the son of John Frederick and Mary (Dixon) Lockwood. Mr. Lockwood early acquired a taste for mineralogy, biography, history, engineering and chemistry, and by indomitable perseverance gained a wide acquaintance with these subjects, long ago becoming a recognized authority in his special electrical branches of study. For a short time he attended a day school at West Smethwick, but his studies were ended at the age of ten, and since then he has had no further academic instruction, his various accomplishments having been self-acquired by home study and practical experience. His first employment was washing emery at the Birmingham Plate Glass Works, which he began in 1859. He entered the machine-shops of the factory in 1861, and worked there, learning and practicing the trade of machinist, until 1865. In that year he immigrated with the family to Port Hope, Ontario. Here he was employed at first in a machine-shop and then in a tannery, but soon learned telegraphy; and in 1867 became the first operator at Port Hope for the Provincial Telegraph Company. Here, and in subsequent telegraphic positions, he preferred night work, as affording better opportunity for the study of electricity, which he continued steadily and effectively, so that on the invention of the telephone by Bell he was one of the few thoroughly equipped to take a leading part in the introduction and improvement and development of the new instrument and its principal utilization, the Telephone Exchange.

The telegraph company having failed, he sought other employment, becoming finisher in the mills of the Smith Paper Company at Lee, Mass. In 1869 Mr. Lockwood went to New Albany, Indiana, where he aided in establishing works for making polished plate glass. This was the first American plant of the kind, and it was he who ordered the first machinery to be imported for such work. This factory afterwards contributed to the great fortune from which W. C. DePauw endowed DePauw University. On the creation of this industry, Mr. Lockwood wrote a four-column article on plate glass manufacture for the "Scientific American," and thus began the literary labors that since then have been so extensive.

In 1871, while the glass furnaces were temporarily not in operation, he taught school at Helena, Arkansas, and incidentally learned why the salaries offered and paid there at that time for male teachers were high.

Working his way East in 1872, he served in various capacities for the Housatonic Railroad and the Delaware, Lackawanna and Western Railroad, being successively, or contemporaneously, ticket clerk, freight clerk, telegraph operator, chief clerk and paymaster in the master-mechanics' department, signal operator, and even brakeman, fireman and locomotive engineer.

Going to New York in 1875, he became inspector of a private fire-alarm service and subsequently filled important positions with the Gold and Stock Telegraph Company and the American District Telegraph Company. In this work, which he followed until 1879, he had unusual advantages for improving his practical knowledge of telegraphy.

In 1879 he joined and was the first of the company of electricians which was being enlisted by the telephone industry, becoming Assistant General Inspector and Installer of Exchanges for the National Bell Telephone Company, afterwards the American Bell Telephone Company. In 1881 he organized and was placed at the head of a new bureau of patent and technical information which the company had decided to establish. For nearly forty years he has continued his invaluable services for the American Telephone and Telegraph Company and its predecessors, and for many years has been General Patent Attorney of the Company, with offices in New York and Boston. On July 1, 1917,

he retired from this office, and while now desirous of leisure and of more time for himself, holds, and expects to hold for some time to come, an advisory position as Consulting Patent Attorney.

Mr. Lockwood is the author of several important books on electrical subjects, and has written innumerable technical articles and papers. His first book was "Information for Telephonists" (New York, 1881), which comprises many articles of practical value. The "Text-Book of Electrical Measurement" (New York, 1883) followed. "Electricity, Magnetism and the Electric Telegraph" (New York, 1885) is a treatise in the form of questions and answers, and was admirably planned to give a general survey of the theory and practice of electricity and magnetism up to the date of its appearance. He edited a translation of "Ohm's Law," which was published in 1890. Among the more noteworthy of his other writings were a series of articles on "Practical Telephony" that appeared in the Western Electrician in 1887. "History of the Word Telephone," in the Electrician and the Electrical Engineer, in 1887; and "Telephone Repeaters or Relays," in the Electrical World, in 1895. He has made many inventions in electrical methods and apparatus. These include the Automatic Telephone Call, patented July 11, 1882, and "Means for Preventing Telephone Disturbances Due to Electric Railroads," patented November 20, 1888. He has given some attention to Burglar Alarms and Alarm Systems.

Mr. Lockwood is a public speaker of much ability. He is in demand for papers at society meetings and as a lecturer, and he possesses great facility of expression in extemporaneous addresses. He was lecturer before the Lowell Institute, on the Telegraph and Telephone, in the winter of 1883; Associate Professor of Telegraphy, Telephony and Patent Law at the Brooklyn Polytechnic Institute, in 1904-05; and is an occasional lecturer at many colleges.

Mr. Lockwood belongs to the Masonic Fraternity, is a member of the Algonquin, Exchange and Engineers' Clubs, Boston; Engineers' and Whitehall Clubs, New York; is a Fellow of the American Institute of Electrical Engineers, of which also he has been Manager and Vice-President; Member of the Institution of Electrical Engineers, London; Honorary Member of the National Electric Light Association and the Association of Railroad Telegraph Superintendents, and Life Member of the American Geographical Society. He is also a member of the First Baptist Church at Melrose, Massachusetts, in which city he has resided for many years; and finds relaxation and pleasure in traveling, reading, astronomy, whist and chess. Mr. Lockwood found early inspiration in the optimistic biographies of Samuel Smiles, especially in "Lives of the Engineers." He asserts that he owes much also to "The American Telegraph" of Pope; "The Encyclopedia Britannica"; Crecy's "Civil Engineering"; "The Pilgrim's Progress"; and Dick's "Christian Philosopher." He has given much attention to the collection of a reference and technical library, which is especially rich in works relating to telegraphy, telephony and electricity.

Mr. Lockwood was married October 29, 1875, to Mary Helm, daughter of George Helm, late of Port Hope, Ontario; of two children born, the survivor is Arthur G. F. Lockwood, who is in business in New York.

ROBERT TEN EYCK LOZIER

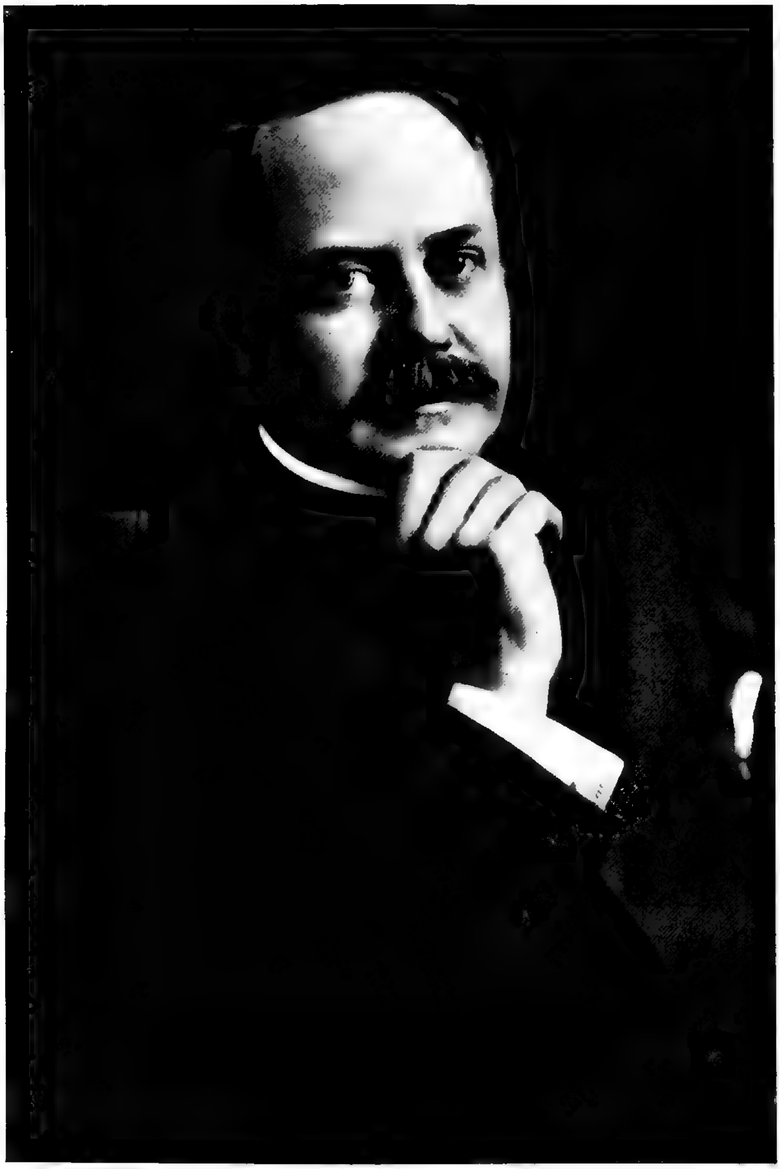
Robert Ten Eyck Lozier, who relinquished his engineering practice in New York City to enter the Government service at the Naval Airplane Factory, League Island Navy Yard, Philadelphia, was born in South Norwalk, Conn., May 5, 1868. He became assistant statistician of the Edison Electric Light Company, February 18, 1883, and shortly afterwards was transferred to Mr. Edison's private office. Mr. Lozier was one of the group of pioneers in the development of the electric light, power and railway industries, and was actively engaged with the Edison construction department in the building of the first electric light stations in this country. He was the first electrical engineer for the Sprague Electric Company, and continued in that position for thirteen years, finally becoming assistant to the General Manager of the Lighting Department and Manager of the Isolated Light-

ing Department. For eight years he was General Manager of Sales for the Bullock Electric Manufacturing Company. Following this for thirteen years he was in general consulting practice. Mr. Lozier was a protégé of Thomas A. Edison. He started with him when fourteen years of age, and was closely associated with the great inventor in much of the experimental and development work that he carried on at the Edison Machine Works in Goreck Street, New York City, and later at his laboratory at Llewellyn Park, New Jersey. He was the originator of the Edison Medal Fund and secretary of the Edison Medal Association. He was also closely associated with Frank J. Sprague, and with him followed the art, both in the shop and in the field, until he finally reached a position that enabled him to become consulting engineer for large financial interests. Mr. Lozier made the first designs for the drum type of railway controller, and in 1888 assisted in building and testing the first multipolar (annular frame) generator at Edison's laboratory. He was one of the pioneers in the introduction and use of individual motors for machine drive, and also in the development and application of the so-called "Teazer" system for operating large newspaper printing presses and directed the installation of these equipments in the principal newspaper offices of the United States. Mr. Lozier has taken out several patents on motor control. He is a member of the Engineers Club, Railway Club, Greenwich Country Club, a Fellow of the American Institute of Electrical Engineers, a life member and past president of the New York Electrical Society.

JESSE R. LOVEJOY

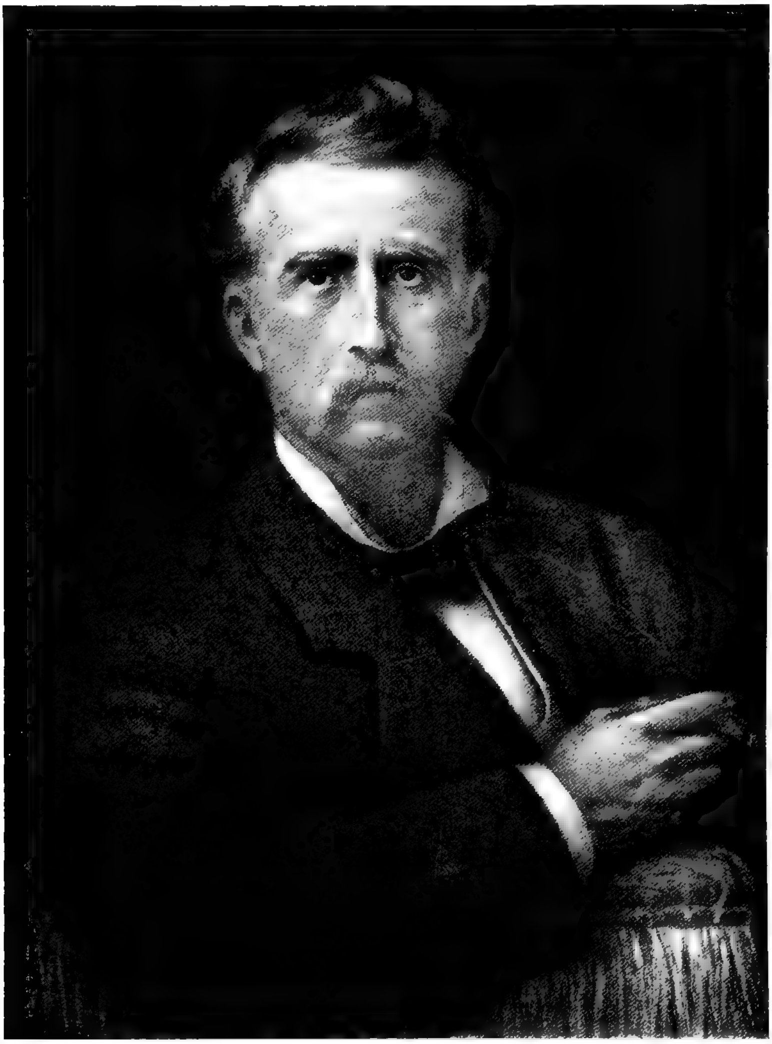
Taking up electrical work through a desire to enter a new field of activity because of the many possibilities presented by that science, and strengthened in his determination by early training and the subsequent sound advice of Dr. T. C. Mendenhall, of the Ohio State University, Jesse R. Lovejoy has accomplished the desires of his early youth and risen to a position of prominence in the electrical world.

Mr. Lovejoy was born in Columbus, Ohio, November 10, 1863, and was educated at the Ohio State University, where he took the engineering course and graduated in 1884 with the B.Sc. degree. In 1886 he entered the works of the Thomson-Houston Co., Lynn, Mass., as an apprentice, and after mastering the details of construction of electrical apparatus, assisted the management of the company in various capacities. He continued in the service of the General Electric Company, which succeeded the Thomson-Houston Co., and was made department manager and finally general sales manager and vice-president of the succeeding company, still retaining the latter position. He is also president and director of several companies affiliated with the General Electric Company. Mr. Lovejoy is a son of Nathan Ellis and Carrie Perkins (Drew) Lovejoy, who removed from New England to Ohio early in life, and to them Mr. Lovejoy ascribes his entire success. He is a Fellow of the American Institute of Electrical Engineers, a member of the Franklin Institute of Philadelphia, American Association for the Advancement of Science, National Electrical Light Association, American Electric Railway Association, Ohio Society of New York, Adirondack League Club, Bankers' Club, Sleepy Hollow Club, Mohawk Golf Club, and the Mohawk Club. Mr. Lovejoy was married June 23, 1891, to Mary E. Gould of Lebanon, N. H.



JESSE R. LOVEJOY
Vice-President of the General Electric Company
(*See Opposite Page*)

Managing Officials of the Postal Telegraph-Cable Company, Including the Late John W. Mackay, the Founder of this World-Embracing System.



JOHN WILLIAM MACKAY
(Deceased)

John William Mackay, who was born in Dublin, Ireland, November 28, 1831, came to America with his family in 1840, attended school in New York City, learned the shipbuilding trade in the New York yards of W. H. Webb, and when the gold discovery in California lured adventurers to the Pacific Coast he went with ar overland party in 1851. He gained a tech nical and practical knowledge of mining, which he followed in California with varying fortunes until 1860, when he went to Nevada and became one of the leading men of the Washoe country. He acquired

valuable interests along the far-famed Comstock Lode. He was one of the discoverers of the famous "Bonanza" ore body which was uncovered in 1872 in the Consolidated Virginia and adjoining claims in Virginia City. There were five shares of this Bonanza property, of which Mr. Mackay owned two, and one each belonged to James C. Flood, James G. Fair and William O'Brien. It proved to be the most valuable silver property in the history of mining industry. Mr. Mackay personally supervised production during the most profitable period of the exploitation of the "Bonanza" properties, taking out vast fortunes for himself and his partners. In 1878, in association with Messrs. Flood and Fair, he founded the Bank of Nevada, with headquarters in San Francisco. Mr. Mackay was a man of sound business judgment and after attaining his large fortune was much abroad, thus becoming familiar with the international telegraph cable situation. He was much impressed with the great possibilities for expansion of transatlantic cable communication and the need for better service and lower rates. With James Gordon Bennett, proprietor of the New York Herald, he laid two cables across the Atlantic to England and France from the United States, and thus founded the Commercial Cable Company, to be followed in 1886 by the organizing of the Postal Telegraph-Cable Company, of both of which companies he remained President until his death on July 20, 1902. He possessed a high order of executive and organizing ability and was a man of initiative and high ideals, who put his compelling personality into all his undertakings. He was also known as a connoisseur of art and a dispenser of broad and effective charity.

CLARENCE HUNGERFORD MACKAY

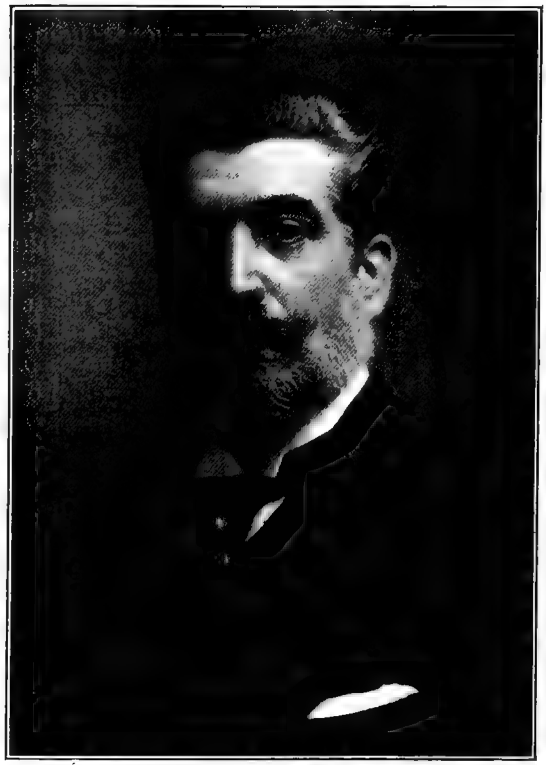
Called at the age of twenty-eight to be the head of the great Postal Telegraph-Cable Company and Commercial Cable Company in the position of president, which he has now held for fifteen years, Clarence Hungerford Mackay occupies a place of great prominence among those who hold the mastery of space. He was born in San Francisco, April 14, 1874, the only son of John William and Marie Louise (Hungerford) Mackay. His mother was a daughter of Colonel Daniel C. Hungerford of old New England lineage and a veteran of the Mexican and Civil Wars. Mr. Mackay spent most of his early life in London and Paris; was educated at Vaugirard College, Paris, and at Beaumont College, Windsor, England, his education being chiefly so directed as to give him a grasp of large affairs. He entered his father's office in New York in 1894, and for two years was in active preparation for his future career. He became president of the American Forcite Powder Company in 1896, serving until 1899. He became a director in 1896, vice-president in 1897, and since the death of his father in 1902 he has been president of the Commercial Cable Company, the Postal Telegraph-Cable Company, Postal Telegraph Building Company, and is now also president of The Mackay Companies, Commercial Cable Company of Cuba, Commercial Pacific Cable Company, and altogether is a director of some thirty corporations. He is a director of the Metropolitan Opera Company; director of the Saratoga Association for the Improvement of the Breed of Horses, and of the Westchester Racing Association and a member of the leading clubs. Mr. Mackay

CLARENCE H. MACKAY
President Postal Telegraph-Cable Company and Commercial Cable Company

in his earlier years was a notable patron of the turf and maintained a large stable of thoroughbreds which many times carried his colors to victory on the metropolitan tracks. But in 1902, after the death of his father, Mr. Mackay disposed of his racing stable and withdrew from turf activities. He gives the large interests which he controls a close personal attention. Under his direction both the land and ocean systems of telegraph service have been widely extended, including the laying of a cable to the Orient; and the enterprise is now a world-embracing one of international fame and influence, known far and wide as the Mackay Companies System.

GEORGE GRAY WARD

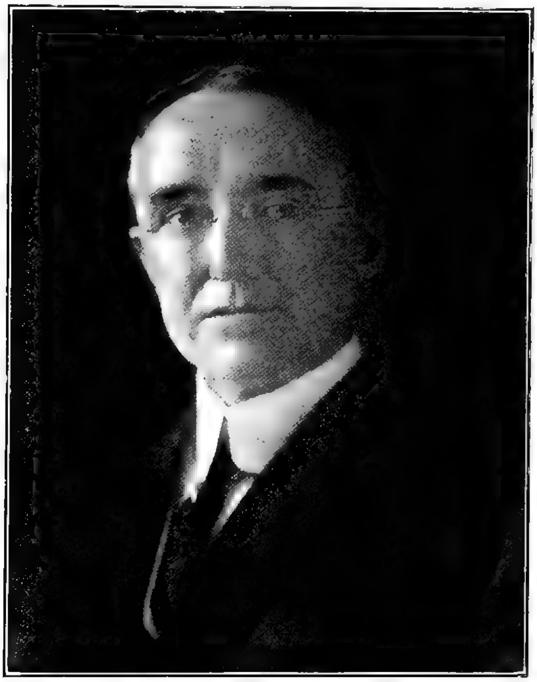
In the upbuilding and present greatness of the Commercial Cable and Postal Telegraph-Cable Companies no one has borne a more constructive part than George Gray Ward. He was born in Hertfordshire, England, December 30, 1844, and received part of his education in Cambridge, England. He became associated with the late John W. Mackay in organizing the Atlantic and Pacific cables of the Commercial Cable Company, of which he is Vice-President, General Manager and Chairman of the Board of Directors. The active direction of the cable laying work of the company in both oceans was confided to his hands, with such success that upon the completion of the cables from the United States to Germany and later to Japan his constructive share in them received Imperial recognition by the conferring upon him of the decoration of the Royal Prussian Crown in 1900 and the Japanese Order of the Rising Sun in 1906. Mr. Ward bears merited distinction as one of the men who have done most to weld together the nations of the earth by putting them in close communication with each other. He has been closely identified with the Mackays, father and son, in the progressive efforts and able management which have created the wonderful and world-compassing land and ocean telegraph system they now control. Mr. Ward, besides his important place in the Commercial Cable Company organization, is vice-president of the Commercial Cable Company of Cuba; vice-president, general manager and director of the Commercial-Pacific Cable Company; vice-president and trustee of The Mackay Companies; vice-president and director of the Postal Telegraph Building Company; president and director of the United States and Haiti Telegraph and Cable Company, and is a director of the Postal Telegraph-Cable Company, the United States Mortgage and Trust Company, and the National Surety Company. Mr. Ward is a member of the American Institute of Electrical Engineers and is honorary treasurer for the United States of the Institution of Electrical Engineers of Great Britain. It has been his good fortune to see many changes and much progress in telegraph service since he entered it and to bear a constructive part in that wonderful evolution.



GEORGE GRAY WARD
Vice-President and General Manager Commercial Cable Company

EDWARD REYNOLDS

Thirty-five years of active service have given Edward Reynolds, vice-president and general manager of the Postal Telegraph-Cable Company, a place of marked distinction as one whose knowledge of the telegraph business is complete and whose contributions to methods of efficiency in telegraph management are of unsurpassed value. He was born in Catskill, New York, November 11, 1866; was educated at the Catskill Academy, and was graduated from that institution in 1881. His first business activity was in the employ of a druggist, where he was under training for a career in the profession of pharmacy.



EDWARD REYNOLDS
Vice-President and General Manager Postal Telegraph-Cable Company

But after he had thought it over he concluded that he would rather be a telegrapher than a druggist, and, giving up the drug business after a few months, he began telegraph service as a messenger. His advance was steady. He applied himself to the business given him to do until he had mastered it thoroughly, and then became a telegraph operator and later office manager. In these capacities he worked for about eleven years, and then became, for about six years, the chief clerk to a district superintendent (operating officer). For the following two years he was chief clerk to the Vice-President, having charge of the lines and offices and the handling of traffic over the entire Postal Telegraph-Cable System. He became general auditor for the entire system for about twelve years, and in 1912 Vice-President and Assistant to the President. Since 1913 he has been Vice-President and General Manager in charge of all operations. This is a record of thorough training—technical, practical and executive—such as few men have had. Its successes indicate talents and capacities equally exceptional, and the combination, rarely attained, of perfect mastery of detail with the ability to take broad control of operations of so vast and complex a character as those of the Postal Telegraph-Cable Company. He has accomplished much constructive work in promotion of efficiency in telegraph administration. Mr. Reynolds is a charter member, was an organizer, and was ten years secretary and two years president of the Greene County Society in the City of New York. He is a member of the Wykagyl Country Club of New Rochelle, N. Y., and the Magnetic and Hardware Clubs of New York City.

CHARLES CLOSSON ADAMS

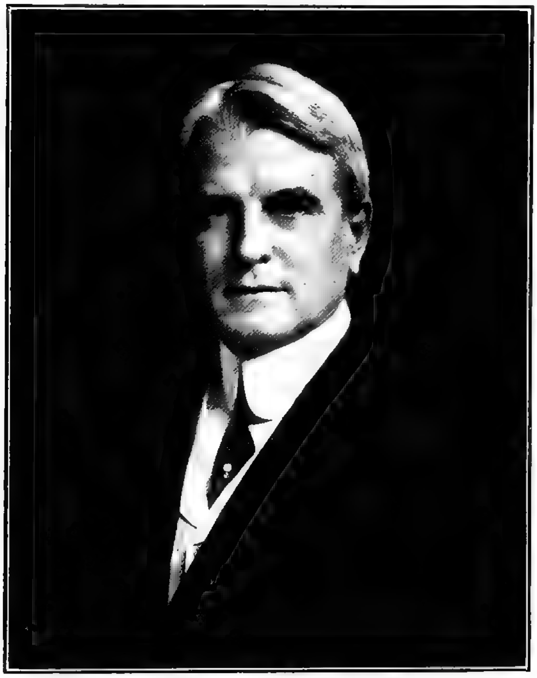
The men who have by their experience and ability so developed the Postal Telegraph-Cable Company and its related organizations as to have set a new mark for efficiency in telegraph service are largely those who entered the service of the company on its organization. One of these who has had a constructive part in the organization of the company's plans and policies is Charles Closson Adams, who, since 1904, has been a Vice-President and director of the Postal Telegraph-Cable Company. Mr. Adams was born in Freeport, Pennsylvania, and after completing the courses in the Pittsburgh public schools he continued his studies at the Sharpsburg Academy. From there he went into telegraph service as an operator with the Columbia Conduit Oil Pipe Line and later with the Atlantic and Pacific Telegraph Company and the Western Union Telegraph Company, soon becoming an expert at that work, and afterwards going to Fort Wayne, Indiana, as telegrapher for the Associated Press. When the Mutual Union Telegraph Company was organized in 1880 he entered its force and was assigned to duty as manager of that company at Pittsburgh, Pa., in which capacity he continued until the company, in turn, was absorbed by the Western Union. He returned to newspaper work for a period, but on the organization of the Postal Telegraph-Cable Company in 1884 he became manager and superintendent at Philadelphia. He was afterwards general superintendent of the Southern Division of the company, with headquarters at Atlanta, Georgia, until 1904, and from there came to New York to assume his present position as vice-president of the company. While his activities have largely centered in the development of telegraph efficiency he has had other interests, and, among others, built at Niagara Falls in 1895 the first plant for the manufacture of calcium carbide (acetylene gas). During his residence in Philadelphia, Mr. Adams was prominent in civic affairs. On appointment by the Governor of Pennsylvania, he served as a Commissioner of Valley Forge Park from 1898 to 1902, and during the same period also served as Civil Service Commissioner for the City of Philadel-

CHARLES C. ADAMS
Vice-President Postal Telegraph-Cable Company

phia. He is a director in the numerous subsidiary companies of the Postal Telegraph System and has an active and influential part in the management of the company. He is a member of the Nassau County Mosquito Extermination Commission and its Treasurer. He is United States Fuel Administrator for the South Shore District of Nassau County, Long Island; President of the Village of Lawrence, N. Y., and a director of the Nassau County Hospital. He is a member of the Union League, the Lotos, the Magnetic (of which he is President) and Hardware Clubs of New York, and the Rockaway Hunting Club of Cedarhurst, L. I.

CHARLES PATTERSON BRUCH

Charles Patterson Bruch, a Vice-President and director of the Postal Telegraph-Cable Company, is a telegrapher by heredity, his father, Captain Samuel Bruch



CHARLES P. BRUCH
Vice-President Postal Telegraph-Cable Company

(brevetted Lieutenant-Colonel shortly before his death in March, 1865), having been General Manager of the Southwestern Telegraph Company, and in charge of United States Military Telegraphs, Division of the Mississippi, and two uncles also having been telegraphers. He was born in Louisville, Kentucky, but was reared at Canton, Ohio. After preparing to enter college, in the junior year of the course he decided he would rather study telegraphy, and on June 1, 1878, after intensive study and practice from February 20, previous, he regularly entered as a telegraph operator in the office of the Western Union Telegraph Company at Canton, Ohio. In the Fall of 1878 he came to New York and was employed in the Western Union main office at 195 Broadway, remaining as operator and clerk until May, 1883. He then became secretary until 1888 of the Telegraphers' Mutual Benefit Association (now the Telegraph and Telephone Life Insurance Association). He became a member of the Executive Committee of that Association 1894-1897 and has since been its vice-president. From 1888 to 1891 he was connected with various enterprises in which the late Ezra T. Gilliland was interested, acting as his assistant and personal representative in official and managerial connection with several electrical enterprises. He entered the service of the Postal Telegraph-Cable Company, June 1st, 1891, serving as assistant secretary until 1898, then assistant general manager until 1905 and since then vice-president and assistant general manager. He is Major in the Signal Section of the Officers' Reserve Corps, United States Army; member of the committee on Telegraphs and Telephones of the Council of National Defence, and member of the Mayor's Committee on National Defence. He is a charter member and past president of the Ohio Society of New York; charter member of the Magnetic Club of New York, was its first president 1888-1889, and again its president 1908-1913; member and has served in official capacities in the Indian Harbor Yacht Club (Greenwich, Conn.); New York Telegraphers' Aid Society, Old-Time Telegraphers' and Historical Society, and other related organizations, and is a member in the second generation of the Society of the United States Military Telegraph Corps. He has been a witness and active participant in the remarkable evolution of the telegraph for nearly four decades.

WELCOME I. CAPEN

Welcome I. Capen, who is now Vice-President in charge of construction of the Postal Telegraph-Cable Company, is another one of the class of telegraph officials whose thoroughness is backed by an experience that, beginning as a messenger boy, has gone through operating and managerial advancements to high executive position. He was born in Brattleboro, Vermont, July 25, 1854; was educated in the public schools of that town, and in 1864 began telegraph service in the local office of the Vermont, Boston and Montreal Telegraph Company. He later became an operator with that company, and afterwards served as operator and wire chief with several telegraph companies of that period, including, successively, the Western Union, Franklin, Southern and Atlantic, Automatic, Atlantic and Pacific, Baltimore and Ohio, and Bankers' and Merchants' Telegraph Companies. In 1885, while the present Postal Telegraph-Cable Company was in process of formation, Mr. Capen was appointed manager of the Cincinnati office, where he remained until he was appointed Superintendent in 1890, the company's first superintendent appointed in the territory of the Western Division. He was promoted, in 1906, to General Superintendent of the Western Division, with headquarters in Chicago, and in 1909 came to the New York headquarters as the General Superintendent of Plant for the entire Postal Telegraph-Cable System, and since 1912 has been Vice-President in charge of construction. As an expert and directing head of construction work on the many and constantly extending lines of the Postal Telegraph-Cable Company, Mr. Capen is famous among the members of the telegraphic profession and has a wide-flung certificate of efficiency in the unequalled excellence in work and materials of the telegraphic lines of that great system which parallels the highways traversing all States and sections of this country, the choice of those materials and the general executive management of that constructive work being vigilantly controlled by him, including the building of new lines, the stringing and insulation of wires and the making of repairs from ocean to ocean and from the Gulf to the Canadian border. Mr. Capen is devoted to his work, the excellence of which is an important factor in the physical perfection for which the Postal Telegraph-Cable System is famous. Mr. Capen is a member of the Magnetic and Hardware Clubs ot New York.

WELCOME I. CAPEN
Vice-President Postal Telegraph-Cable Company

JOSEPH B. McCALL

Joseph B. McCall, a dominant figure in the electrical field and in the commercial life of Philadelphia, has been president of the Philadelphia Electric Company since

JOSEPH B. McCALL

its organization, and has been a most conspicuous figure in giving the Quaker City the best electric light and power facilities possible. He has also found time to devote to public welfare movements. His first thought, however, has been the development of the company which he heads and his energies have been concentrated in the extension of its field of operation until it is now one of the most complete and important public utility corporations in the country.

Mr. McCall was born in New York City, May 12, 1870, but was taken to Philadelphia when a child and educated in the public schools of that city. In 1885 he secured employment in the law office of Rufus E. Shapley, where he read law and studied stenography. Rufus E. Shapley was one of the leading lawyers of the city and there is no doubt Mr. McCall would have been successful in that profession with such an able preceptor, but his mind turned to other pursuits and after a year of communion with Blackstone, he started to work for the Pennsylvania Globe Gas Light Company. He quickly familiarized himself with the duties of his new position and being energetic and efficient, rose through successive promotions to the position of secretary of the company. In 1895 he was one of the organizers of the Pennsylvania Heat, Light and Power Company of which he was chosen secretary and treasurer. Three years later this company was absorbed by the Pennsylvania Manufacturing, Light & Power Company. Mr. McCall became president of the new organization and when it in turn was absorbed by the Philadelphia Electric Company he became the directing head of that corporation. He has labored indefatigably for the company to the exclusion of other commercial enterprises which he has been solicited to join, the one exception being the directorship in the First National Bank, one of the strongest of Philadelphia's financial institutions. Mr. McCall served as president of the Association of Illuminating Companies from 1904 until 1907 and was also president of the National Electric Light Association, 1913-1914. He is a member of the American Institute of Electrical Engineers, and of the Franklin Institute of Philadelphia. He is also a member of the Country, Racquet, Merion Cricket Clubs, The Associates of Philadelphia and the Union League, of which he was formerly vice-president. Mr. McCall was married September 30, 1889, to Lenore Adah Guest and has two sons and one daughter.

LOUIS C. MARBURG

LOUIS C. MARBURG

Louis C. Marburg was born March 8th, 1876, at Wiesbaden, Germany, where his parents, American citizens, were residing at the time. He was graduated from the Gymnasium at Wiesbaden in 1894, having been prepared for a "practical" career by many years' study in Latin and Greek. The same year he entered one of the plants of Sulzer Bros. of Winterthur, Switzerland, the well-known engine builders, as apprentice, successively passing through the different departments of the large factory. Thus he soon learned the rudiments of the practical side of the profession he expected to follow and became acquainted with the shop methods of an establishment standing, according to the unanimous opinion of European engineers, at the head of the manufacturing industry abroad. After this experience he became connected with the Allgemeine Elektrizitaets Gesellschaft of Berlin as an assistant in electrical installation work.

In the fall of 1895 Mr. Marburg entered the Technical High School of Charlottenburg, choosing the course in electrical engineering.

Mr. Marburg mentions that the choice of his profession was actually made at the age of ten, when, by chance, he came in contact with a series of elementary lectures by Professor Tyndall on "Experiments in Electricity."

Although rather premature, this choice of profession was final and resulted in the establishment of a primitive workshop and experimental laboratory. Here was made many a valuable discovery, long since forgotten, while incidentally school work was being neglected.

After a year's study in Charlottenburg, Mr. Marburg attended the Technical High School of Hanover and finally that of Darmstadt. Among the professors at these colleges, whose lectures Mr. Marburg was fortunate in attending, were Riedler, Kohlrausch, Kittler, Guthermuth and others prominent in scientific and practical work. Various college vacations were spent in the experimental departments of Siemens & Halske of Berlin, assisting in the testing of standard machines and in research work.

In 1898 Mr. Marburg went with the Sprague Electric Company, becoming connected with the famous pioneer work of Mr. Frank J. Sprague in installing the Multiple Unit System on the South Side Elevated in Chicago. In 1900 he moved to Schenectady, where he remained for over four years in the railway department of the General Electric Company, assisting in the designing of railway motors and later in the designing of power stations.

In 1904 Mr. Marburg accepted an offer to join the forces of the Allis-Chalmers Company, which at that time entered the electrical field. Owing to the connection established about this time between the Allis-Chalmers Company and the Bullock Electric Company, the Electrical Department made its headquarters at Cincinnati, where Mr. Marburg looked after the sale of power plants and car equipments and supervised the design of electric power plants. In 1895 he was transferred to the Allis-Chalmers Contracting Department in Milwaukee, and soon after was appointed Engineer of the Department in charge of its engineering work.

Among the power plant designs originating during this period under his supervision are the stations of the Toledo, Port Clinton and Lake Side Railway, the Sandusky, Norwalk and Mansfield Railway, the Indianapolis, New Castle and Toledo Railway, the electrical parts of the high pressure fire service stations in New York and many other steam driven and water power stations in various parts of the country.

In 1907 Mr. Marburg was appointed Mechanical Engineer of the Gas and Mill Engine Department. He followed closely the operation of the gas engine power stations of the steel plants at South Chicago and Gary, which were equipped with Allis-Chalmers machinery.

To parallel operation of gas engine driven alternators he devoted particular attention and made it a special study during a trip aboard.

In 1908 Mr. Marburg was placed in charge of electric hoisting work, another subject which he investigated in Europe.

Mr. Marburg is now Secretary and Treasurer of Marburg Brothers, Inc., Engineers, Exporters & Importers, New York, a corporation formed in 1910 to import engineering specialties from Europe, to represent European inventors in the exploitation of their patents in this country, and also to export engineering products and raw materials to all parts of the world.

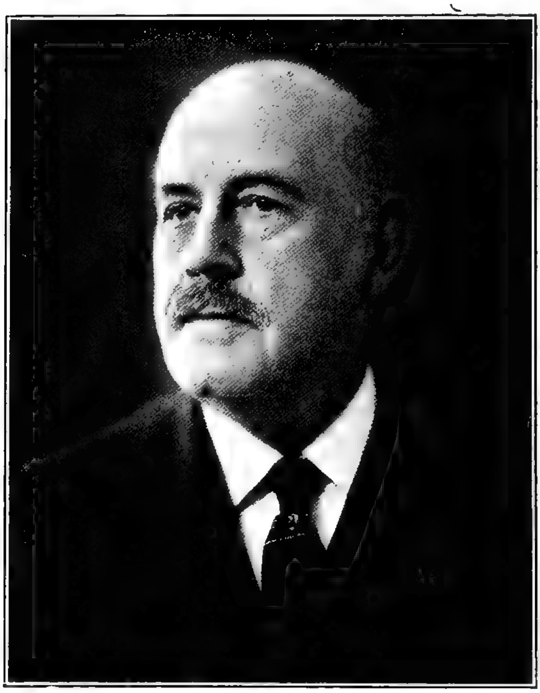
At one time Mr. Marburg was among the special contributors of "Elektrische Kraftbetriebe & Bahnen" of Berlin. There are a number of patents issued in his name covering various electrical improvements in connection with power distribution.

Mr. Marburg is a Fellow of the American Institute of Electrical Engineers, a Member of the American Society of Mechanical Engineers, New York Electrical Society, Verein Deutscher Ingenieure of Germany, and the Electrical Society of Berlin. He is also a member of the Engineers' Club of New York, the League to Enforce Peace, the American Society for Judicial Settlement of International Disputes, the Railroad Club and the Glen Ridge Country Club.

Mr. Marburg's business address is 90 West Street, and he resides at 24 Franklin Place, Montclair, New Jersey.

JAMES T. MAXWELL

The electrical profession has recently lost one of its most useful and admired members in the late James T. Maxwell. By



JAMES T. MAXWELL

none so much as by his own immediate associates has his eminent ability and fineness of character been recognized. They were the personnel of the Philadelphia Electric Company, of which he was a leading organizer and executive. An uninterrupted term of service with them began in 1888, when he joined the Edison Electric Light Company as general agent. From the commercial department of the Edison Company grew the commercial department of the consolidation of a group of electric lighting companies in Philadelphia, forming the Philadelphia Electric Company. As general agent in charge of the contract department, Mr. Maxwell won a high reputation for business judgment and knowledge of conditions entering into rate making. In his youth he had seen years of service as a telegraphist. Thrown upon his own resources at an early age, he was first employed by the Western Union Telegraph Company in New York City, but in 1870 he went to Philadelphia, where he served successfully and in responsible positions a number of the competing telegraph companies until one after another they were absorbed into the Western Union system. Mr. Maxwell was born January 1, 1848, in New York City. He was a life member of the Navy League of the United States and a member of the National Electric Light Association, the Illuminating Engineering Society, the Jovian Order and other professional and social organizations.

ARCHIBALD J. MARTIN

ARCHIBALD J. MARTIN

Archibald J. Martin, whose entire life has been devoted to the construction and installation of electrical and power equipment, is a pioneer in that branch of the service. When he entered the field the science was in its infancy. The arc light was at an experimental stage; incandescent installation was in an embryonic state and Van Depoele had not perfected his system of electric street car propulsion. The institutions of learning, as a rule, did not include in their curriculum a complete course in this invisible agent, which was destined to become one of the greatest forces known and furnish heat, light and power to the world; and the man doing pioneer work in those days was compelled to meet the many obstacles by personal investigation and individual application. There were no established precedents to govern and the electrician of forty years ago was the "trail blazer" who paved the way for the wonderful development of the present day. How well these conditions were met by some of the workers in the field, is shown by the story of Mr. Martin's achievement. He was born in Brooklyn, October 22, 1860, and with only an ordinary school education to start him on his successful career, eventually became identified with every phase of electrical development. His first employment was with the firm of Arnoux, Hochhausen & Co., who were manufacturers of single arc lights, the first of which was installed on the Old Iron Pier, Coney Island. This work was under Mr. Martin's supervision, and bare copper wires were used. Mr. Martin gained wide experience with this firm and his next connection was with the Edison Company, 65 Fifth Avenue, where he served in the capacity of specialist in installation and construction. Thence he was sent to Philadelphia by the same company to install the electrical apparatus on Jay Gould's yacht, then building at Cramp's shipyard, and from there he was detailed to the middle west, where he had charge of the erection of several isolated plants. His next connection was with the Thomson-Houston Company at Lynn, Mass., and for this company he installed at Northampton, Mass., one of their first incandescent lighting central stations. He also erected a three-wire station at Dover, New Hampshire, a central station at Orange, Mass., another at Amherst, Mass., and several others in that territory. The company then sent him to Philadelphia, where he erected the Germantown central station for the electric company and while in that city he engineered the first interior conduit system ever installed. This was in a large apartment house for William G. Warden, of the Standard Oil Company. He also built the West End Electric Company's central station in Philadelphia. At that time this was one of the first complete systems with wires completely underground. Returning to New York City he had charge of the equipment of the first electrical show ever held in the Grand Central Palace, and after superintending the building of an electrical railroad in St. Louis, he returned to New York City, and in 1896 organized the Commercial Construction Company, of which he became president and of which he is now sole owner. This brief synopsis of his activities along all lines will show his equipment to conduct business for himself. Since the Commercial Construction Company entered the field, Mr. Martin has installed electrical and power equipment for residences, clubs, apartment houses, hotels, institutions of every character, hospitals, schools, public buildings, factories, bridges, power houses, subways, loft buildings and transmission lines. In this work he has invaded many states and South America and his clientele includes some of the best known and wealthiest men in the country, the most important manufacturing concerns and the largest institutions. These activities have run into many millions of dollars and the success of the company is the result of Mr. Martin's long and varied experience and a thoroughly seasoned organization which has kept in close touch with the steady progress in the electrical and power field. Mr. Martin is an associate member of the American Institute of Electrical Engineers and is a member of the Crescent Athletic Club of Brooklyn, and several kindred organizations. His offices are at 8 and 10 Bridge Street, New York City.

ALBERT H. MANWARING

Albert H. Manwaring, electrical engineer, who has directed some of the most important electrical installations throughout the country during the past two decades, has by his achievement taken first rank among the workers in the electrical industry. His career has been one of continuous success and he has played a most important part in the development of the science. Mr. Manwaring was born in Mexico, Oswego County, New York, but removed early in life to Cleveland, Ohio, and was educated principally in the schools of that city and at the Bryant & Stratton Business College. His thoughts turning to electricity as presenting the best possibilities of the period, he determined to take up that work and was soon enrolled as an employee of the Brush Electric Light Company of Cleveland. This was in August

ALBERT H. MANWARING

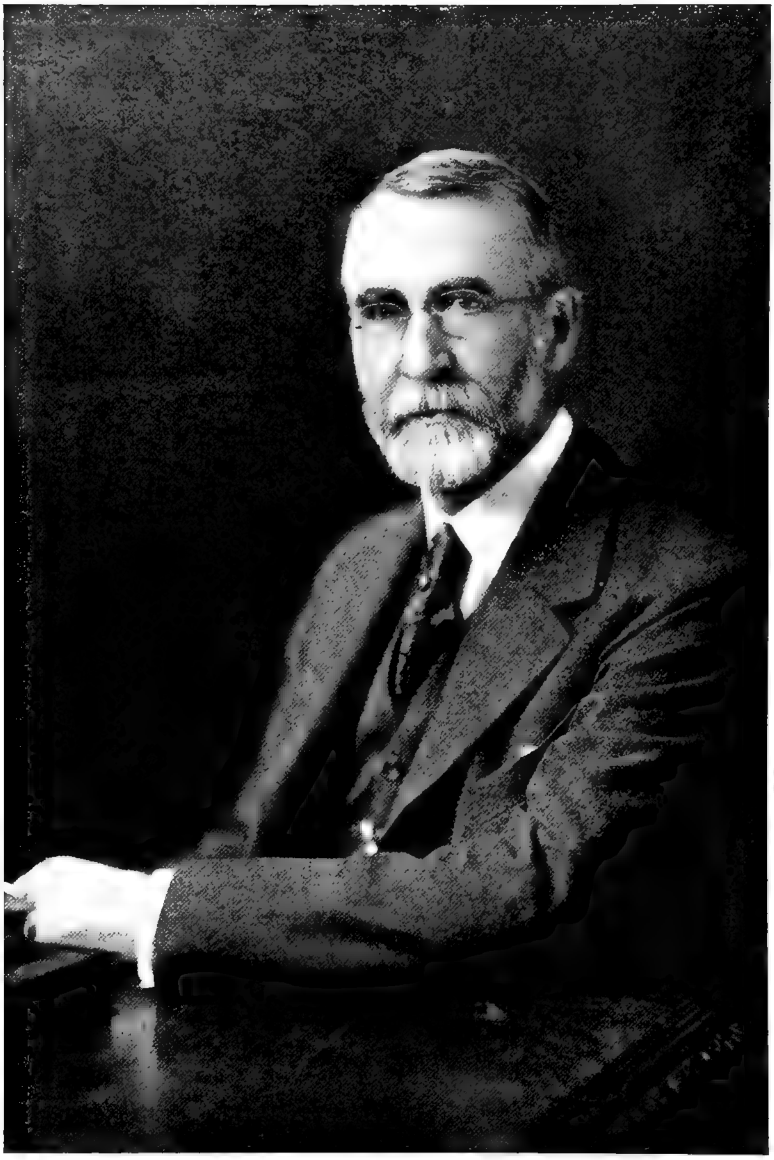
1880, and his position, assisting in the manufacturing of carbons for arc lamps, was an ordinary one, but it was the first stepping stone in the career he had selected. Performing his work to the satisfaction of his employer he was soon transferred to the lamp department, where he assembled arc lamps. Mr. Manwaring manifested such ability in mastering the details of electrical work that he was assigned by the company to take charge of the construction and direction of electrical plants for the eastern agency in Philadelphia, since which time he has made that city his home. The plants Mr. Manwaring installed previous to 1882 included the Jackson & Sharp Car Works, Wilmington, Delaware; William Sellers Co., Philadelphia, Pa.; Delaware & Lackawanna Iron & Coal Co., Scranton; Reading Coal & Iron Works, Reading; Blain Car Works, Huntington, Pa., and other less important ones. In August, 1881, he took charge of the installation and remodeling of electric light plants for the Thomson-Houston Co., and while with them he installed or remodeled the Cavern of Luray, Virginia, the Midvale Steel Works, the Girard Hotel and many other large operations. In 1882 he accepted a position with the Brush Electric Company of Philadelphia and was placed in charge of the commercial wiring. He was made general superintendent of the Electric department in 1890 and later was appointed engineer of the Philadelphia Electric Company, a position he still retains. He is a member of the Engineers Club of Philadelphia, Franklin Institute, National Electric Light Association, American Institute of Electrical Engineers, the Jovian Order, the Chamber of Commerce and Manufacturers Club of Philadelphia, Ohio Society of Philadelphia, Old York Road Country Club of Philadelphia and the Bucks County Country Club of Bucks County.

ROBERT D. McCARTER

ROBERT DALE McCARTER

Among the American engineers who have attained international reputations through achievements abroad, none have been more active than Robert D. McCarter. He was born in Emporia, Kansas, September 10, 1872, and after a preparatory education entered the Ohio State University, where he took a special course and graduated in 1895 as an electrical engineer in mechanical engineering. Immediately upon graduation he took the student's course at the General Electric Company's works at Schenectady, New York, and Lynn, Mass., during the years of 1895-97. While still with the Schenectady works of the General Electric Company in 1899, he was sent to Berlin as Chief Designing Engineer. He remained in this position for one year and when the company opened an export office in London he was sent to the English metropolis as Chief Engineer of that branch. He left the General Electric Company's employ in 1902 and opened an office as Consulting Engineer in London, and has continued to practice consulting engineering from that period to the present time. From 1902 until 1907, Mr. McCarter specialized in electric tramways in England, and in addition to being Consulting Engineer in nearly all instances, he managed the operating companies as well as carried out the construction work. From 1907 to August, 1914, as Consulting Engineer to the European Westinghouse Companies, and the President and Managing Director of the Westinghouse Electric & Manufacturing Company in Russia, he was compelled to do considerable traveling on the Continent, especially in European Russia, which gave him an exceptionally good insight into European conditions in general. At the commencement of the European War Mr. McCarter was appointed a member of the Committee in London to assist Americans in returning to the United States. He returned to this country in 1914. When the Commission for Relief in Belgium was formed, Mr. Hoover asked Mr. McCarter to take charge of the commercial activities in America. He accepted the position and was Honorary Secretary to the commission during the first year of the relief work in Belgium, during which time he organized in this country all the commercial departments of the commission, including shipping, freight, purchasing foodstuffs, etc. Although born in Kansas, Mr. McCarter made his home in Columbus, Ohio, from 1875 until 1895, and from 1900 until shortly after the start of the European War in 1914, his headquarters were in London. Since that his offices have been located at 165 Broadway, New York City, and his home at Rye, New York.

Chronologically, Mr. McCarter's activities are: 1897-1899, assistant designing engineer direct current machinery and rotary converters, General Electric Company, Schenectady; 1899-1900, chief designing engineer in charge of D. C. machines, rotary converters, street railway motors, etc., Union Elektricitäts Gesellschaft (affiliated with the General Electric Company), Berlin, Germany; 1900-1902, chief engineer of the General Electric Company's export office in London; 1902 to date, consulting engineer under the firm name R. D. McCarter, London and New York. His important work, carried out from 1902 to date, was consulting engineer and general manager to Bath Electric Tramways, Ltd., England; consulting engineer and general manager to Falkirk and District Electric Tramways, Scotland; consulting engineer and general manager to Sunderland District Electric Tramways, England; consulting engineer to the Amsterdam and North Holland Electric Railway Company; consulting engineer of Petrograd Street Railways during construction; consulting engineer to Ceara Electric Power Tramway Lighting Company, Ceara, Brazil; consulting engineer Tucuman Hydro-Electric Company, Argentine; general manager and consulting engineer to the Westinghouse Electric Company, Ltd., London; consulting engineer to the Société Electrique Westinghouse de Russie, and president and managing director of the Société Electrique Westinghouse de Russie, 1910-1913. Mr. McCarter is a member of the Union League Club, Engineers' Club, India House, Railroad Club, American Institute Electrical Engineers, The Pilgrims' Automobile Club, London, and the English Club, Moscow.



CHARLES T. MAIN
Consulting Engineer. President, 1918, of the American Society of Civil Engineers
(*See Next Page*)

CHARLES THOMAS MAIN

Charles Thomas Main, consulting engineer and mill expert, was born in Marblehead, Essex County, Massachusetts, February 16, 1856, the son of Thomas, Jr., and Cordelia (Reed) Main, and grandson of Thomas and Deborah (Phillips) Main and of Lemuel Fish and Eunice (Holmes) Reed. He is a descendant of the Rev. George Phillips, who, with his wife and two children, left Boxted, Essex, England, and on April 12, 1630, embarked on the "Arbella," landing at Salem, Massachusetts Bay Colony, June 12th following, having Winthrop and Saltonstall as fellow passengers and becoming the first minister of Watertown. One of his sons was the Rev. Samuel Phillips (1625-1696); one of his grandsons, Samuel Phillips, of Salem, and one of his great-grandsons, John Phillips (1701-1768), who married Mary, daughter of Nicholas Buttolph of Boston, and their great-grandson was Wendell Phillips (1811-1884), the abolition leader. Other ancestors were William Reede of Weymouth, Mass., who arrived from England in 1635, and William Holmes, born in England in 1592, who settled in Marshfield, Plymouth Colony. Mr. Main's father, Thomas Main, Jr., was a machinist and engineer in Marblehead, where Charles Thomas attended the public schools, and under a private tutor was prepared for matriculation at the Massachusetts Institute of Technology, from which institution he was graduated S.B. 1876, and remained at the institute as an assistant instructor for three years, 1876-79. He was draughtsman for the Manchester Mills, Manchester, N. H., in 1879; engineer for the Lower Pacific Mills, Lawrence, Mass., 1880-85, having charge of the reorganization of the plant, assistant superintendent Lower Pacific Mills 1885, and superintendent 1886-91. After 1891 he engaged in general engineering work, and since that time he has designed and supervised the construction of a large number of textile mills and other industrial plants, including steam and hydro-electric operations, and is consulting engineer of many other projects. He has made reports of proposed developments, valuations on properties using steam and water power for various purposes, erected mill buildings, store, boiler and engine houses, made plans for worsted and woolen yarn mills, made reports on the reorganization of plants and water power construction. His field of operation, while principally in New England, has extended through various states as far west as the Pacific Coast and to Canada. Perhaps the most interesting of Mr. Main's work along electrical lines, was designing and supervising the construction of four hydro-electric plants for the Montana Power Company. These stations are from 45,000 to 90,000 H.P. capacity.

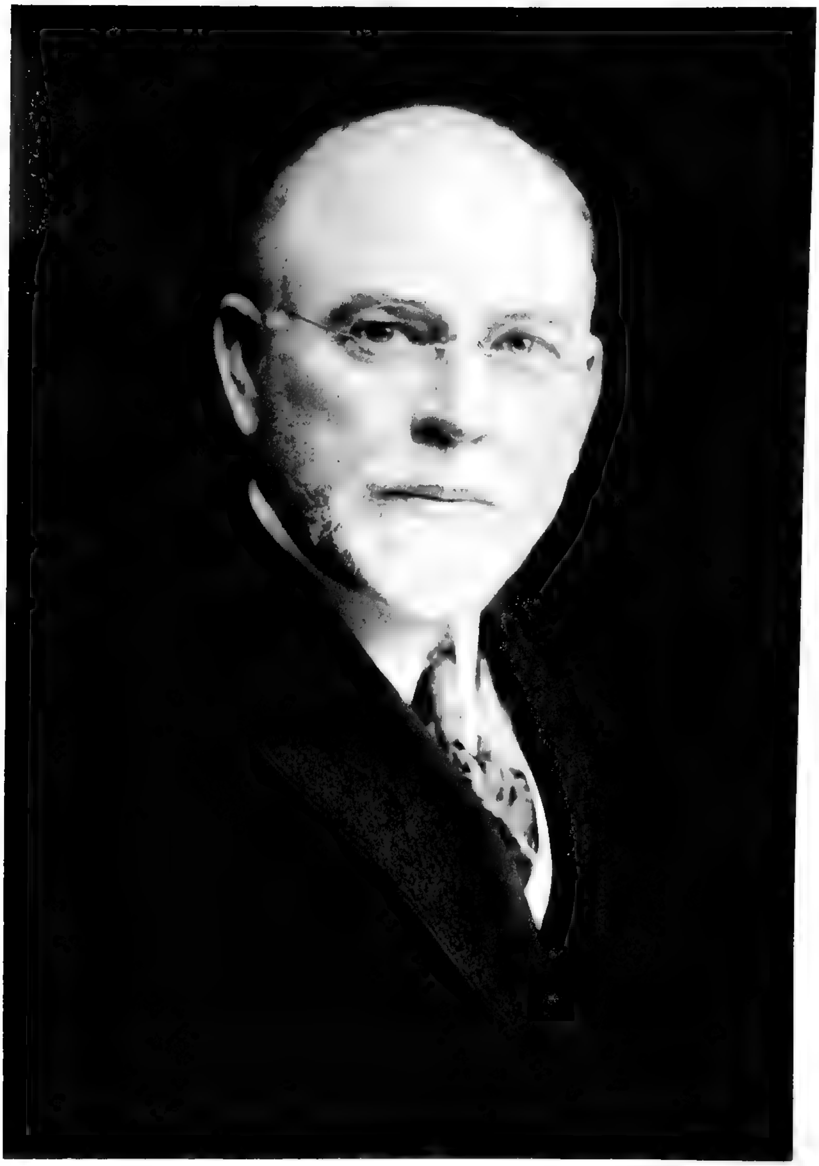
His offices are at 201 Devonshire Street, Boston. He was married November 14, 1883, to Elizabeth, daughter of John and Mary (Jane) Appleton, and after a residence in Lawrence of eleven years, removed to Winchester. While a resident of Lawrence he served as alderman of the city 1888, 1889 and 1890, and a member of the school committees and trustee of the public library 1891. In Winchester he served as a member of the water board from 1895 to 1906. In 1905 he was elected a term member of the Corporation of the Massachusetts Institute of Technology. He is a member of the American Society of Mechanical Engineers, and President in 1918, member American Society of Civil Engineers, member of the National Association of Cotton Manufacturers, member and past-president of the Boston Society of Civil Engineers. His social affiliations include membership in the Exchange, Engineers, president of the Engineers' Club 1914 to date, and Technology Clubs of Boston, The Engineers' Club, New York, and Calumet Club of Winchester. His published papers read before scientific societies, of which he is a member, covered the subjects: "Steam Power," "Water Power," "Mill Construction," "Valuation of Industrial Properties," etc. He invented a receiver pressure regulator for compound engines, which was widely used.

DANIEL McFARLAN MOORE

The name of Moore is perpetuated in a public sense by the Moore Light, the history of which is an interesting part of the narrative of its inventor's career. The prolific inventiveness of Daniel McFarlan

DANIEL McFARLAN MOORE

Moore and his fertile experiments in producing light by the flow of electricity through various gases, have been an ever recurring subject of comment in scientific circles. His inventions protected here and abroad number over one hundred, beginning with the first patent taken out in 1893. The following year the Moore Electric Company and the Moore Light Company were organized, of both of which Mr. Moore was vice-president and general manager for a period of eighteen years, or until their absorption into the General Electric Company. At various stages of its development the Moore Light was a featured attraction at electrical expositions, as at the Grand Central Palace in New York in the 90's, and as shown a while later at Madison Square Garden, where the "Moore Chapel," lighted with vacuum tubes, excited the wonder of visitors. Eventually there was a permanent installation of Moore Lights provided for the Garden, lengths of tubes totaling four miles in all. Soon they came into general commercial use, and Moore Light Companies were found as far away as Russia, Switzerland, France and Germany. One of the modified forms of the Moore Light exhibited at the New York Electrical Show of 1916 was a unit supplied with Neon gas. Another, using carbon dioxide gas, duplicated exactly the best quality of daylight, and in consequence is regarded as a standard of comparison for the color values of light and has been invaluable to the textile industry. The city of Philadelphia, through the Franklin Institute, awarded to Mr. Moore the John Scott medal and premium in 1910, and in 1912 Sir William Ramsay sent him, as a mark of esteem, a bottle of the precious Neon gas, an element discovered by the donor. Mr. Moore's papers upon the subject of light, presented in the form of lectures before scientific societies and as articles in the periodical press, have been in many instances authoritative in description, explanation and power of prophecy. Mr. Moore was born in Northcumberland, Pa., February 27, 1869, the son of Rev. Alexander Davis and Maris Louisa (Douglas) Moore, a scion of ancestry distinguished in the service of the country from early Revolutionary times. He was married on June 5, 1895, to Mary Alice Elliott of New York City. Their three children are Dorothy Mae, 1900; Elliott McFarlan, 1902, and Beatrice Jean, 1912. Their home is at 510 Park Avenue, East Orange, N. J., and Mr. Moore's office is at the plant of the General Electric Company, at Harrison, N. J. Mr. Moore is a Fellow of the American Institute of Electrical Engineers, a past chairman of the Illuminating Engineers Society and a member of the New York Electrical Society, also the American Association for the Advancement of Science. He is a member of the Society of the War of 1812 and is vice-president of the Orange Chapter of the Sons of American Revolution.



JAMES H. McGRAW

JAMES H. McGRAW

James H. McGraw, the leading technical publisher in America, if not indeed, in the whole world, was born at Panama, Chautauqua County, N. Y., December 17, 1860, and graduated as valedictorian of his class in 1884 from the State Normal School, Fredonia, N. Y. He taught school for some years in Western New York, but found his way to the Atlantic seaboard and entered the field of trade and technical journalism, then in a very primitive stage of development.

At heart an educator, Mr. McGraw in leaving the professional field of teaching, brought to publishing a viewpoint of service which, combined with his energy and ambition, has been fundamentally responsible for the growth of his papers as publishing properties.

His first venture into active publishing was as Philadelphia representative of the American Railway Publishing Company, and in 1888 he became the active head and publisher of the *Street Railway Journal,* a weekly journal of authority and influence throughout its career, and continuing as the leading journal in its field up to the present time as the *Electric Railway Journal.*

In 1896 he founded the *American Electrician,* and soon after, in 1899, purchased the *Electrical World* and *Electrical Engineer,* consolidating these three properties into the *Electrical World.* With the amalgamating of the forces of these publications came the McGraw Publishing Company in the year 1899, and offices were established in Chicago, London, Denver and San Francisco.

Building and serving as a part of the industry itself, the business of the McGraw Publishing Company soon necessitated the occupancy of larger quarters. The McGraw Realty Company, organized in 1905, put up on West Thirty-ninth street the first large reinforced concrete structure of its kind in New York, and the pioneer publishing home in the now great district bounded by the *Herald* and *Times* home north and south, the Public Library on the east, and the present McGraw headquarters on Tenth avenue at Thirty-sixth street. Associated with this enterprise was the creation of a huge printing establishment.

Mr. McGraw's vision of the industry and his conception of the possibility of the widening influence of electricity in the applied fields of commerce and industry led him to establish *Chemical and Metallurgical Engineering,* which has now become a journal of the industry of international reputation.

In the same spirit of serving completely every constructive group in the industry, *Electrical Merchandising* was established as the creative influence in the development of the electrical trade in the new branches of retailing which grew out of the constantly widening application of electricity to industrial, commercial and domestic life.

This belief in the fundamental background of engineering as a basis for progress in our nation, led to the purchase of the *Engineering Record,* which was made a most progressive and successful weekly in the civil engineering and construction field of activity. An incidental episode in serving the engineering profession, as a publisher, was the foundation of the McGraw-Hill Book Company, understood to be the largest publisher of technical and applied engineering books on the American continent.

It was but natural with Mr. McGraw's conception of the relation of journalism to industry that in 1917 came the consolidation of the McGraw Publishing Company and the Hill Publishing Company, by which, with Mr. McGraw at its head, the McGraw-Hill Publishing Company, Inc., adding to the journals above named, became proprietors also of *Power, American Machinist, Engineering News, Engineering & Mining Journal and Coal Age.*

As a corollary to this great move, the two civil engineering papers were merged into the *Engineering News-Record,* the largest and most complete publication of its kind in the English language.

This brief summary compresses in short space a career of achievement based upon the best and soundest ideals of progres-

sive American journalism. Mr. McGraw has kept before him always the fundamental philosophy of the educator, the desire to serve, and to establish and maintain the leadership of his publications by a complete and thorough service.

The McGraw publications have each and all been leaders in their respective fields, and have been agencies and advocates of all that is highest in engineering and industrial advance. Such work might well absorb all the thought and energy of a crowded life, but Mr. McGraw has found time for active participation in Republican politics and Y. M. C. A. work in New Jersey; for banking in New York City, and for prominent engineering service, notably in building up the great American Electric Railway Association. He is also a member of the American Institute of Electrical Engineers, and of the Engineers', Railroad and Republican Clubs.

CLOYD MARSHALL

The city of Lafayette, Indiana, is not a great metropolis, but a small city of about twenty thousand people, but there is scarcely another city of the United States which for its size has produced a larger number of people notable in literature, science and professional life. One of the reasons for its prominence is that it is the home of Purdue University, a state institution where two thousand students, on the average, are in training, and which has a standing for its excellent work. It was one of the first of the Western schools to specialize in mechanical and electrical science, and in that and other technology courses its standards are of the best.

Cloyd Marshall, electrical engineer, was born in Lafayette on August 5, 1873, grew up amid the excellent scholastic surroundings of the place, went in due time to Purdue University, from which he was graduated Bachelor of Mechanical Engineering in 1893 and Electrical Engineer in 1900. He was elected to the honor society of Tau Beta Pi on graduation in 1895, and became a member of Sigma Alpha Epsilon fraternity while in the university. He became electrical editor of the *Street Railway Review* in 1895, and later he entered upon the contracting and manufacturing branches of electrical business in New York City, where he is a member of the firm of Firth & Marshall, at 81 New Street, and treasurer of the Wireless Improvement Company, at the same address. He is also secretary and treasurer of the Dubilier Condenser Company, of 217 Centre Street, New York.

CHAPTER VII.

THE ELECTRICAL SOCIETIES

Reviews of the Leading Organizations Established for the Promotion of the Electrical Industry

THE old adage that "two of a trade can never agree" is obsolete. It never expressed a universal truth, as is evidenced by the success of the ancient trade guilds; but in this Electric Age, when every capital city of the world is within a few minutes of Broadway by electric communication, the old saw has entirely lost its point. Cooperation rather than competition is the "life of trade," and every successful profession, business or cult owes much to organizations that are formed to promote mutual interests, to standardize practice and to bring about united action for the common good.

In the profession of electrical engineering, and also in the electrical industries, the value of associated counsel and united effort was early recognized. Mutual exposition of the researches and experiences of pioneers in many lines of scientific knowledge and electrical applications created a body of technical data of vast value to electrical engineers, and, through them, to the world. Hence many electrical societies have been organized and have continued to contribute in an important degree to electrical progress. Some of them are here noted, being arranged in the chronological order of their earliest organization:

New York Electrical Society.

The oldest electrical society in the United States is the New York Electrical Society, which was organized February 23, 1881. On that date a prominent group of telegraphers met at the famous old United States Hotel, corner of Fulton and Water Streets, New York, and Francis W. Jones was elected President; George B. Scott, Dr. P. H. Van der Weyde, Gerrit Smith, W. J. Dealy, George A. Hamilton, George G. Ward, Vice-Presidents; J. W. Moreland, Secretary, and M. Brich, Treasurer.

The Society has a distinct mission, which has been thus defined: "One crucial fact should never be lost sight of, and that is that the New York Electrical Society is the one and only electrical body in New York that covers the entire field of electrical science, industry and trade, besides other scientific fields. Its usefulness has earned for it and claims the affiliation of every electrical man in New York, whatever his profession or occupation."

In the thirty-seven years of its existence it has been addressed by many of the most notable scientific men of this and other countries, among whom may be mentioned: Admiral Bradley A. Fiske, Dr. E. J. Houston, Dr. C. O. Mailloux, Dr. Michael I. Pupin, Dr. Schuyler S. Wheeler, Professor Elihu Thomson, Dr. A. E. Kennelly, Professor W. E. Ayrton, Dr. Louis Bell, Peter Cooper Hewitt, Senator Guglielmo Marconi, John J. Carty (Col.), T. Commerford Martin, and Elmer A. Sperry. In addition to the high standard which has thus been created for its ordinary monthly meetings, the Society has made a notable mark in its "Visiting Meetings," which gives its members opportunities to study at first hand new developments in electrical and scientific progress. One of such meetings

was held on the ill-fated steamship "Lusitania," when six hundred of its members inspected the ship and its up-to-date electrical features, and were afterwards entertained in the grand saloon.

The Presidents of the Society have been Francis W. Jones, 1881-3; Charles S. H. Small, 1883-4; Professor P. H. Van der Weyde, 1884-7; John M. Pendleton, 1887-9; Professor Francis B. Crocker, 1889-92; Joseph Wetzler, 1892-4; C. O. Mailloux; 1894-5; John W. Lieb, Jr., 1895-6; Dr. C. E. Emery, 1896-7; Dr. Michael I. Pupin, 1897-8; Gano Dunn, 1898-1900; T. Commerford Martin, 1900-1; Arthur Williams, 1901-2; Dr. Samuel Sheldon, 1902-3; John J. Carty (Col.), 1903-4; Frank J. Sprague, 1904-5; William S. Barstow, 1905-6; George Herbert Condict, 1906-7; Dr. Albert F. Ganz, 1907-8; Henry A. Lardner, 1908-9; Theodore Beran, 1909-10; Robert T. Lozier, 1910-11; John Bottomley, 1911-12; Henry L. Doherty, 1912-13; H. H. Barnes, Jr., 1913-14; Frederick A. Scheffler, 1914-15; Elmer A. Sperry, 1915-16; Putnam A. Bates, 1916-17; Dr. A. S. McAllister, 1917-18; A. L. Doremus, 1918-19.

J. W. Moreland was the first secretary of the society and A. A. Knudson the second. He was succeeded by Joseph Wetzler, and he by George H. Guy, the present incumbent.

Association of Railway Telegraph Superintendents

The Association of Railway Telegraph Superintendents was organized in Chicago November 20, 1882, for the purpose of promoting the advancement of the telegraph, telephone, and other electrical departments of railroad service. Conventions are held annually at some designated railroad point. Except W. K. Morley, the first president, who served two years, a new president has been elected at each annual meeting, the President's office thus changing to his business headquarters. The first Secretary-Treasurer was C. S. Jones, and P. W. Drew, of Chicago, who was elected June 3, 1883, was annually re-elected for thirty-three terms, his last election being at St. Paul, June 20, 1916, but a few months later, Mr. Drew resigned, and W. L. Connelly of Gibson, Ind., was selected as secretary and treasurer in his place. The presidents elected have been: W. K. Morley, 1882, 1883; C. Selden, 1884; C. W. Hammond, 1885; A. R. Swift, 1886; G. L. Lang, 1887; G. C. Kinsman, 1889; C. A. Darlton, 1889; G. T. Williams, 1890; C. S. Jones, 1891; L. H. Korty, 1892; U. J. Fry, 1893; O. C. Greene, 1894; M. B. Leonard, 1895; G. M. Dugan, 1896; J. W. Lattig, 1897; W. W. Ryder, 1898; L. B. Foley, 1899; W. F. Williams, 1900; C. F. Annett, 1901; J. H. Jacoby, 1902; C. S. Rhoads, 1903; H. C. Hope, 1904; E. E. Torrey, 1905; E. A. Chenery, 1906; E. P. Griffith, 1907; W. J. Camp, 1908; J. L. Davis, 1909; I. T. Dyer, 1910; G. A. Cellar, 1911; J. B. Sheldon, 1912; W. Bennett, 1913; W. C. Walstrum, 1914; E. C. Keenan, 1915; M. H. Clapp, 1916.

American Electric Railway Association

This association was not originally an electrical society, as its first organization antedated the electric railway. It was organized as the American Street Railway Association at a meeting held in Boston on December 12 and 13, 1882. In September, 1905, the name of the Association was changed to the American Street and Interurban Railway Association; and in October, 1910, to the American Electric Railway Association. In 1905 the Street Railway Accountants' Association of America, the American Railway and Mechanical Electric Association, and the Street Railway Claim Agents' Association of America, were joined with this organization as affiliated bodies; and in 1908 the American Street and Interurban Transportation and Traffic Association was organized as an affiliated association. In February, 1916, the scope of the Association was broadened so as to include manufacturing companies, as well as railway companies, in the membership.

There were fifty-six street railways represented at the organization meeting in Boston in 1882, and H. H. Littell, general manager of the Louisville, Ky., Street Railway Company, was the first president, for the year 1882-3.

The association as now organized has brought into one group body all the national associations working in the interest of electric railways. It has accomplished many important things for the benefit of railway service, notably in work for the standardization of methods and practices. Through it have been accomplished the standard code of operating rules both for street and interurban properties, also important work toward securing the Standard Classification of Accounts for electric railways, and it has created numerous engineering standards and recommendations. It has secured a lowering of insurance rates on electric railway properties, and effective methods of fire prevention; has been a powerful factor in bettering the relations between railway companies and the public, and bringing about a better understanding between the companies and their employees. It has, through its Company Sections and by means of its educational courses, assisted materially in the education of electric railway men; and, through the discussions at its conventions and the acts of its committees, has collected and disseminated information of great value in improving the efficiency of electric railway practices and methods.

The offices of the Association were in Brooklyn, 1882-1895, in Chicago, 1895-1905 and since 1905 have been in New York. The presidents of the Association have been H. H. Littell, 1882-3; William H. Hazzard, 1883-4; Calvin A. Richards, 1884-5; Julius S. Walsh, 1885-6; T. W. Ackley, 1886-7; Charles B. Holmes, 1887-8; George B. Kerper, 1888-9; Thomas Lowry, 1889-90; Henry M. Watson, 1890-1; John G. Holmes, 1891-2; D. F. Longstreet, 1892-3; H. C. Payne, 1893-4; Joel Hurt, 1894-5; H. M. Littell, 1895-6; Robert McCulloch, 1896-7; Albion E. Lang, 1897-8; Charles S. Sargent, 1898-9; John M. Roach, 1899-1900; Walton H. Holmes, 1900-1; H. H. Vreeland, 1901-2; Jere C. Hutchins, 1902-3; W. Caryl Ely, 1903-6; John I. Beggs, 1906-7; C. G. Goodrich, 1907-8; James F. Shaw, 1908-10; Arthur W. Brady, 1910-11; Thomas N. McCarter, 1911-12; George H. Harries, 1912-13; Charles N. Black, 1913-14; C. Loomis Allen, 1914-15; Charles L. Henry, 1915-16; L. S. Storrs, 1916-17; John J. Stanley, 1917-18, and J. H. Pardee, 1918-19.

The Secretaries have been, William J. Richardson, 1882-95; Thomas C. Pennington, 1895-1905; Bernard E. Swenson, 1905-9; H. C. Donecker, 1909-13; E. B. Burritt since 1913.

American Institute of Electrical Engineers

The profession of electrical engineering has had a development more remarkable in the rapidity of its rise than any other in history. In this achievement no factor has been more potent than the organization which, when the profession, as we now know it, was in its formative period, was created for the purpose of bringing its members together for counsel and improvement and for the general advancement of electrical research and achievement.

The American Institute of Electrical Engineers was organized in New York on May 13, 1884. A preliminary meeting of the founders was held on April 15, 1884, in response to a call which had been circulated to a considerable extent among men identified with electrical activities and interests. The list of those signing the call is of interest as a most representative one of those who in that early day (electrically speaking) were prominent in divers ways in such electrical interests and projects as were then being conducted or promoted. The following, many of them still living, were signers of the call: Norvin Green, A. W. Dimock, Thomas A. Edison, George B. Prescott, Frank L. Pope, George A. Hamilton, Gerrit Smith, Roland R. Hazard, Charles L. Buckingham, Charles S. H. Small, Stephen D. Field, A. D. Schuyler, L. E. Curtis, Edward Weston, C. O. Mailloux, E. A. Leslie, Charles D. Haskins, J. A. Seely, J. H. Bunnell, George B. Scott, S. B. Eaton, W. H. McGrath, H. Seymour Geary, A. B. Chandler, William Hochhausen, George D. Allen, A. A. Hayes, Augustus C. Graham, George M. Hopkins, L. G. Tillotson, G. V. B. Frost, R. D. Buchanan, Edward Callahan, William C. Behrens, T. H. Delano, William H. Childs, Frank Shaw, Charles J. VanDepoele, C. E. Chinnock, H. L. Bailey, Theodore Mace, W. H. Eckert, Robert Brown, E. N.

Dickerson, Jr., D. Van Nostrand, W. J. Johnston, Francis W. Jones, James W. McDonough, Thomas R. Taltavall, P. H. Van der Weyde, A. K. Eaton, F. A. P. Barnard, C. F. Chandler, W. P. Trowbridge, Thomas Egleston, F. S. Newberry, F. R. Hutton, J. H. Van Amringe, J. K. Rees, Joseph P. Davis, D. H. Bates, N. S. Keith, W. A. Hovey, George W. Fuller, Charles A. Randall, W. G. Holcomb, George F. Bulen, Robert Hewitt, Jr., Frank C. Mason, W. D. Sargent, J. C. Reilly, P. L. Watson, C. S. Thompson, A. E. Huntington, Charles L. Clarke, G. L. Beetle, T. C. Martin, George Worthington, F. B. Knight, H. B. Lytle, C. M. Lungren, George C. Maynard, Frank B. Rae, Edwin J. Houston, Thomas D. Lockwood, Elihu Thomson, George W. Stockley, A. A. Hayes. Not all of these men, however, were charter members of the Institute. The men who became charter members were those who attended the preliminary meeting held in response to the call issued by the original signers. Among the charter members still living are the following: Alexander Graham Bell, Adam Bosch, Charles F. Brush, Charles L. Clarke, C. R. Cross, Joseph P. Davis, Patrick Bernard Delany, E. N. Dickerson, Thomas A. Edison, George A. Hamilton, Nathaniel S. Keith, Thomas D. Lockwood, C. O. Mailloux, T. Commerford Martin, Jesse M. Smith, Edward P. Thompson, Elihu Thomson, Elmer A. Sperry, Theodore N. Vail, William B. Vansize, Edward Weston.

A second meeting was held on May 13, 1884, at which a permanent organization was effected, to be known as the American Institute of Electrical Engineers.

The first regular meeting of the Institute, for the presentation and discussion of professional papers, was held during the International Electrical Exhibition in Philadelphia on October 7 and 8, 1884. After holding two annual meetings in New York, the experiment of monthly meetings was begun, in accordance with suggestions made at the Annual Meeting in May, 1885, and these monthly meetings have been continued to the present day, excepting during the summer months.

Having become fairly well established as the national electrical organization of America, it was felt that, as a next step to its development, the Institute should take active steps toward identifying itself with international work, thereby securing proper recognition for the important researches of Americans who were hitherto largely ignored because no organized body representing this country had participated in the international congresses of Europe. Such a Congress was held in Paris in 1889, in connection with the International Exposition, and a delegation from the Institute attended and participated in the Congress, their presence being recorded in the official proceedings. In 1891 the Institute received and accepted an invitation to appoint delegates to attend the Frankfort International Electrical Congress and to take part in its deliberations. The Institute was ably represented by five prominent members. The Frankfort Congress adjourned to meet in Chicago in 1893, at the World's Columbian Exposition, and the Institute on that occasion undertook and carried through to a successful issue the organization of the World's Electrical Congress. The Institute's participation in these three Congresses proved a potent factor in winning recognition abroad both for the Institute and for American electrical engineers.

Its subsequent history is well known. From a small body of a few hundred men struggling for recognition, it has grown into a great engineering organization with a membership of approximately ten thousand, numbering among its members many of the leading engineers of the United States and foreign countries. Its members have organized local Sections in thirty-four of the principal electrical centers of the United States, Canada, Mexico, and Panama; and Student Branches have been established by faculty members who are also members of the Institute in fifty-eight institutions of learning throughout the United States.

It would be difficult to attempt to enumerate the specific achievements of the Institute. Its activities cover every branch of electrical engineering, and practically all of the advances in electrical matters have been made by men who are members of the Institute. Through its work it has

come to be recognized by State and National authorities as the representative body of electrical engineers in this country, and it has frequently been called upon to take action in matters of public importance in various States and by the National Government itself.

Its *Proceedings,* published monthly in two sections, contain news and notices of interest to members, as well as technical papers, reports of committees, and other matters of an engineering character.

Its *Transactions,* published annually, contain selected technical papers, discussions and reports, forming a permanent record of the progress of electricity.

Since its organization, the Institute has had its headquarters in New York. It occupied various down-town locations until 1907, when the Institute found a final home for its executive officers in the building 25-33 West Thirty-ninth Street, New York. The building is the gift of Mr. Andrew Carnegie to the engineers of America as represented by the American Institute of Electrical Engineers, American Society of Mechanical Engineers, the American Institute of Mining Engineers, and the American Society of Civil Engineers. These four societies have an equal interest in its ownership and administration.

The presidents of the American Institute of Electrical Engineers from its organization have been, *Norvin Green, 1884-6; *Franklin L. Pope, 1886-7; T. Commerford Martin, 1887-8, Edward Weston, 1888-9; Elihu Thomson, 1889-90; *William A. Anthony, 1890-1; Alexander Graham Bell, 1891-92; Frank Julian Sprague, 1892-3; *Edwin J. Houston, 1893-5; *Louis Duncan, 1895-7; Francis Bacon Crocker, 1897-8; A. E. Kennelly, 1898-1900; Carl Hering, 1900-1; Charles P. Steinmetz, 1901-2; Charles F. Scott, 1902-3; Bion J. Arnold, 1903-4; John W. Lieb, 1904-5; Schuyler Skaats Wheeler, 1905-6; Samuel Sheldon, 1906-7; *Henry G. Stott, 1907-8; Louis A. Ferguson, 1908-9; Lewis B. Stillwell, 1909-10; Dugald G. Jackson, 1910-11; Gano Dunn, 1911-12; Ralph D. Mershon, 1912-13; C. O. Mailloux, 1913-14; Paul M. Lincoln, 1914-15; John J. Carty, 1915-16; H. W. Buck, 1916-17; E. W. Rice, Jr., 1917-18; Comfort A. Adams, 1918-19.

*Deceased.

The secretaries of the Institute, from its origin, have been, N. S. Keith, 1884-5; T. Commerford Martin (Acting Secretary), 1884-5; Ralph W. Pope, 1885-1911; F. L. Hutchinson, since 1912 to date.

The National Electric Light Association

The National Electric Light Association was organized to foster and promote the effectiveness of the service furnished by electric central station corporations engaged in the production, transmission and distribution of electricity, in supplying the public with light, heat, power and other forms of service. It was believed that the highest economies and efficiencies could be reached only through the effective cooperation of all of the factors engaged in the industry, to which end the Association was founded in 1885 in Chicago. Throughout the thirty-three years following its inception, it has not only fulfilled its original object, but has taken on many newer and broader duties and responsibilities. The Association is in itself a concrete expression of the social and political belief that it is economically unwise for governmental authorities of whatever degree to engage in the ownership and conduct of industrial enterprises. It has also demonstrated that centralization of effort and production, with the greatest possible volume of output, are essential for the furthest economy and efficiency and to provide the maximum expansion, the highest standards of service, and the lowest rates to the public. It has lent its support to the great movement for the conservation of energy and of natural resources. It has favored and promoted reasonable State regulation by Commission rather than wasteful competition, as a means of assuring reasonable rates for service. It holds that no instance exists where public utility competition has not finally been at the expense of the community served, and that a regulated monopoly is the essential condition for best service.

The Association is constructed on an unusually broad basis of membership. Full

membership is limited to operating public utility electric light and power companies, which are designated Class A members. This is followed by four classes of associate members: Class B membership comprises individual officers and employees of Class A members. Class C membership includes teachers in institutions of learning, consulting engineers, officials of Public Service Commissions, and others interested in the scientific development of applied electricity. Class D membership provides for manufacturers of electrical apparatus and mechanical appliances used in connection with electrical supply and service; and Class E is composed of officers and employees of Class D members. There is also a growing class of Foreign Members, corporate and individual, from all parts of the world, to whom the useful activities of the Association make a strong appeal, and by whom its publications are eagerly sought. In a special class of honorary members will be found, without distinction of nationality, the names of great living inventors and creative contributors to the art of applied electricity and many who have sought to shape it for the best service of mankind. These classes now represent a total of more han 12,000 members.

The Association has a governing organization of peculiarly flexible character insuring progressive development and initiative, its Executive Committee being composed of the President—holding office for one year only—four Vice-Presidents, nine Class A or B members, elected by the annual convention to the number of three each year, the Treasurer, the retiring President, and the Chairmen of the National Special Sections. To these recurring annually are added the new Presidents or Chairmen of the Geographic and State Sections elected from the various sections of the country affiliated with the National body.

The engineering and attendant scientific and educational work of the Association, is carried on through appropriate subdivisions of the National organization known as the Technical and Hydro-Electric Section, the Commercial Section, the Accounting Section, and the Electric Vehicle Section. No person is eligible for membership in any of these or in any other National Special Section who is not a member of the Association itself. By far the largest specialized group of this kind within the Association is the Technical and Hydro Electric Section.

The effective working and the continuous usefulness of the Association depend not more upon the administration at headquarters and the guidance of the Executive Committee than upon the vigilant assistance of the numerous standing and special committees of the Association and its National Special Sections. Of these committees there are now about 70 with some 500 leading experts in their membership. If to these are added the corresponding and kindred committees in the Geographic Sections, a total is reached of at least 1000 men in the industry who, without compensation, are devoting their best thought, through the Association, to the development of the art and the consequent benefit to the public. Not only does this service find expression in valuable annual reports that are the landmarks of progress, but in quick and prompt assistance given to members in the solution of pressing problems of the hour, as well as in several handbooks which are permanently valuable contributions to the literature of electricity, and have received very wide appreciation not only from public utility companies and their employees, but from college professors and college students engaged in the engineering courses of colleges and technical schools. This literature is furnished without charge to 120 universities and colleges with engineering courses.

The work of the Association is promoted primarily and principally by educational methods. By far the largest part of its income in dues is returned to its membership in the form of educational publications, including the *Proceedings* and the monthly *Bulletin* in magazine form.

For several years the Association has been developing through Company Sections and with the aid of its National Special Sections a plan of educational work for the higher training and improved efficiency of the men engaged in the industry. These educational efforts are strikingly exemplified in the successful courses of the Commercial Section in Electrical Engi-

neering and Salesmanship, and in those of the Accounting Section; but they are also brilliantly illustrated by the vocational work undertaken in several cities by member companies dealing with their employees at first hand in the endeavor to make them not only more effective men, but, on the whole, better citizens. The Association now has over 50 Company Sections in existence, many of them with their own monthly Bulletins, all holding regular meetings, for the dissemination of knowledge and all inculcating ideals of personal efficiency, enhanced ability to serve, and higher standards of public service. The Association maintains, free of cost to Company Sections, a Lecture Bureau to which leaders in the art contribute each year. The Bureau is a very active center each winter in the circulation of these lectures with the aid of "movies" and thousands of lantern slides. To a great many of these meetings the public has the "open door."

At a very early stage the Association took part in the now universal "Safety First" movement, and is at present cooperating with the U. S. Bureau of Standards to develop and perfect a National Electrical Safety Code. One of its most notable efforts in this direction was its creation of a National medical commission for the study of resuscitation from electrical shock. Sustaining entirely the expenses of this body, which included the most distinguished medical experts in the country, it formulated and published broadcast a brief set of rules and recommendations on this subject. These have been adopted by the U. S. Governmental departments, State bureaus, great railroad systems, and leading industrialists, have been published by a great number of newspapers, and have been translated into many languages and adopted by several foreign authorities. The Association is now taking up this subject anew and has reorganized forces for its consideration in the light of the latest scientific investigations.

It may be mentioned as an evidence of the patriotic spirit pervading the Association that early in 1918, its members companies were represented by no fewer than 14,135 duly recorded officers and men in the U. S. Army, Navy and Signal Corps; by over $43,000,000 in subscriptions to the three Liberty Loans; by $1,588,000 given to the American Red Cross; and by War Savings Stamp sales to the amount of $667,000.

The presidents of the National Electric Light Association have been as follows, those deceased being indicated by an asterisk:

*James F. Morrison of Baltimore.
Samuel A. Duncan of Pittsburgh.
Edwin R. Weeks of Kansas City.
Marsden J. Perry of Providence.
Charles R. Huntley of Buffalo.
*James I. Ayer of St. Louis.
Edward A. Armstrong of Camden, N.J.
*M. Judson Francisco of Rutland.
*C. H. Wilmerding of Chicago.
Frederic Nicholls of Toronto.
Samuel Insull of Chicago.
*Alden M. Young of Waterbury, Conn.
Samuel T. Carnes of Memphis.
*James Blake Cahoon of New York.
Henry L. Doherty of Denver.
Louis A. Ferguson of Chicago.
Charles L. Edgar of Boston.
Ernest H. Davis of Williamsport, Pa.
William H. Blood, Jr. of Boston.
Arthur Williams of New York.
Dudley Farrand of Newark, N. J.
William C. L. Eglin of Phila.
Frank W. Frueauff of Denver.
W. W. Freeman of Brooklyn.
John F. Gilchrist of Chicago.
Frank M. Tait of Dayton, O.
Joseph B. McCall of Phila.
Holton H. Scott of New York.
Edward W. Lloyd of Chicago.
Herbert A. Wagner of Baltimore.
John W. Lieb of New York.
Walter F. Wells of Brooklyn, N. Y.

The Secretary is Mr. T. C. Martin. As assistant secretary, Miss Harriet K. Billings served actively for 20 years until 1909, a record that is probably unique of its kind. The offices have been for many years in the splendid building of the United Engineering Societies, 29 West Thirty-Ninth Street, New York City.

Association of Edison Illuminating Companies

In 1885, James S. Humbird, general agent of the Edison Electric Light Company for the State of Pennsylvania, sent

out a circular letter requesting the various Edison Electric Illuminating Companies to hold a conference at Harrisburg, Pa., on April 15, 1885, and that meeting was attended by H. K. Wood of Piqua, Ohio; Westley Auten and Frank S. Marr, of Sunbury, Pa.; William Schwenk and T. M. Righter, of Mt. Carmel, Pa.; F. S. Hastings and Samuel Insull of New York; James S. Humbird of Cumberland, Md.; H. M. Doubleday, and Francis R. Upton.

The object of the meeting, as stated by Mr. Humbird, was to effect an interchange of opinions among those who were interested in the business, in order to elicit all the information possible for the purpose of advancing their mutual interests. At this meeting "The Association of Edison Illuminating Companies" was organized and its first officers elected as follows: James S. Humbird, President; H. K. Wood, Vice-President; Westley Auten, Treasurer; and Frank S. Marr, Secretary.

From its organization the Association has been active in the prosecution of its objects as stated at the outset, and for the past eight years its headquarters have been in the Engineering Building in New York.

Its Presidents in succession have been James S. Humbird, 1885; John I. Beggs, 1886-93; C. L. Edgar, 1893-6; Samuel Insull, 1896-8; R. R. Bowker, 1898-9; John W. Lieb, Jr., 1899-1901; L. A. Ferguson, 1901-3; Joseph B. McCall, 1903-6; Alexander Dow, 1906-8; W. W. Freeman, 1908-9; Thomas E. Murray, 1909-11; General George H. Harries, 1911-12; Arthur Williams, 1912-14; Walter F. Wells, 1914-16; Peter Junkersfeld, 1916-7; L. L. Elden, 1917-18.

Its Secretaries have been: Frank S. Marr, 1885; J. H. Vail, 1886; W. J. Jenks, 1890-2; W. S. Barstow, 1893-8; Wilson S. Howell, Newark, N. J., 1898-1901; Walter H. Johnson, 1901-3; William S. Barstow, 1903-4; E. A. Leslie, 1904-5; George R. Stetson, 1905-6; Ernest H. Davis, 1906-7; W. W. Freeman, 1907-8; D. L. Huntington, 1908-9; N. T. Wilcox, 1909-11; H. T. Edgar, 1911-12; and from 1912 to 1917 George C. Holberton, to whom succeeded E. A. Edkins.

The Electric Club of New York

The Electric Club was organized in New York in the year 1886. Several gentlemen prominent in electrical circles of those days met in the office of the *Electrical Review* by invitation of George Worthington, editor, and a temporary organization was effected. The first meetings were held at the Hotel Dam, Union Square, and headquarters were established there in a room rented for that purpose. A number of addresses on electrical problems of the day were delivered and discussed, the first one by Dr. Geo. H. Benjamin outlining the need of placing all electric wires underground. This view provoked much discussion in opposition, but soon subsequently the wires were all buried and the poles and network of wires and the few cables of the day disappeared from the streets and housetops of New York, thus establishing Dr. Benjamin's right as a prophet. Another address was by the late Commodore Charles A. Cheever on the Phelps induction telegraph which was just then attracting attention.

In 1887, the Club having grown and prospered, took an entire building at 17 East 21st Street, where it remained until it disbanded in 1892.

The officers included in the group of portraits herewith, were elected in 1887 and were, with a few changes, the same that were elected at the time of the organization the previous year. One error appears in the list of photographs—the face of Mr. James English of New Haven, Conn. appearing over the name of Mr. J. N. Keller of Boston. No photograph of Mr. Keller being obtainable in time for the opening of the Club House, the enterprising Secretary filled the gap with the handiest and handsomest photograph available, hence the grouping which is now corrected for the truth of history.

The Club, which supplied complete service of rooms and meals, was for several years the general meeting place of men interested in all branches of electrical development from all parts of the country, and a number of interesting and timely addresses were delivered. Among those readily recalled were addresses by Prof. Henry A. Rowland, of Johns Hopkins University, Dr. Otto A. Moses, E. T. Gilliland, Dr. Louis Duncan and E. N. Dickerson. The Club installed its own lighting plant largely donated by the liberal manu-

ELECTIVE OFFICERS OF THE ELECTRIC CLUB, 1887-8.

facturers of that period. A complete storage battery plant was donated and installed by the predecessor of the well known Electric Storage Battery Company. Among the generous contributions for the equipment and maintainance of the Club was one of $2,500 by the Metropolitan Telephone & Telegraph Company—now the New York Telephone Company.

The list of Presidents of the Electric Club included Henry C. Davis, E. T. Gilliland, O. E. Madden and Samuel Insull. The membership included resident and non-resident and numbered several hundreds.

In 1892 interest in the Club gradually decreased due to the departure of members to other electrical organizations and to more social clubs, and its doors were finally closed. It can be said that the Electric Club served a most useful purpose in affording an opportunity for the enthusiastic workers in the new science and practice of electricity to become personally acquainted and to benefit by discussion and experience, and find a common meeting ground where rivalries of invention and business did not intrude. The Club undoubtedly was the means of advancing electrical development during those early days full of problems and doubts to the electrical man. When the Club dissolved many of its members found a natural home in the Engineers Club, to which also its steward went, while another large contingent reinforced the ranks of the Lotos Club.

Society for the Promotion of Engineering Education

The engineering professions have had in the past quarter of a century a growth in number of practitioners larger than in all the centuries before. It has been the Age of the Engineer, with a demand for technical and practical engineering service which has outrun the supply. The electrical discoveries, with their manifold applications, have made that branch of engineering increasingly important, and have made a considerable technical knowledge of electricity important for all engineers. The curricula of the engineering and technical schools have therefore been broadened so that the exacting requirements of advanced learning for the modern engineer are met by a teaching body which has kept pace with engineering progress. That this is so, is largely due to the efforts and achievements of the Society for the Promotion of Engineering Education.

This Society was the outgrowth of the meetings of Division E of the World's Engineering Congress, held in Chicago from July 31 to August 5, 1893, in connection with the World's Columbian Exposition. Division E was suggested by Professor Ira O. Baker of the Civil Engineering Department of the University of Illinois. Judge C. C. Bonney, president of the Congress Auxiliary of the World's Columbian Exposition, thought that the meeting of the teachers of Engineering should be held as a part of the Education Congress, but Professor Baker induced him to arrange it as Division E of the Engineering Congress. The World's Auxiliary appointed a special committee to arrange for a meeting of Division E, but the entire work of arranging a programme and working out the details of the meeting fell to Professor Baker.

The attendance at the meetings was very large, and deep interest was aroused. The proposal to form a permanent organization was enthusiastically adopted, and the Society for the Promotion of Engineering Education was organized. Professor De Volson Wood, of the Department of Mechanical Engineering, Stevens Institute of Technology, was elected president, and Professor J. B. Johnson, of the Department of Civil Engineering, Washington University, St. Louis, was elected secretary. The Society was the first organization and apparently, after twenty-five years, is the only one in the world of its kind. After its first year it had 156 members; it now has more than fifteen hundred, among whom are included the leading educators in engineering education in this country and many from abroad. It has helped to raise the standards of engineering education in this country beyond those of many other professions, and it provides a means by which the different studies, such as mathematics, physics, chemistry, mechanics, etc., constituting an engineering curriculum, can be coordinated and correlated.

Its *Proceedings,* published annually since 1894, reveal the complete development of engineering education as it exists in this country. There is also a *Bulletin,* issued monthly from September to June, and various special publications. The living past presidents of the Society are: G. F. Swain, Cambridge, Mass.; Mansfield Merriman, New York; H. T. Eddy, Minneapolis, Minn.; T. C. Mendenhall, Ravenna, O.; Ira O. Baker, Urbana, Ill.; Robert Fletcher, Hanover, N. H.; C. Frank, Boston, Mass.; F. W. McNair, Houghton, Mich.; D. C. Jackson, Boston, Mass.; Charles S. Howe, Cleveland, Ohio; F. E. Turneaure, Madison, Wis.; H. S. Munroe, Litchfield, Conn.; A. N. Talbot, Urbana, Ill.; W. G. Raymond, Iowa City, Iowa; W. T. Magruder, Columbus, Ohio; G. C. Anthony, Tufts College, Mass.; Anson Marston, Ames, Iowa; Henry S. Jacoby, Ithaca, N. Y.; G. R. Chatburn, Lincoln, Nebr., and Milo S. Ketchum, Boulder, Colo.

The present officers are: John F. Hayford, Evanston, Ill., president; John T. Faig, Cincinnati, Ohio, and E. R. Maurer, Madison, Wis., vice-presidents; F. L. Bishop, Pittsburgh, Pa., secretary; and Wiliam O. Wiley, New York, treasurer.

Railway Signal Association

The Railway Signaling Club was organized March 11, 1895, by G. M. Basford, W. H. Elliott, H. D. Miles, W. B. Turner, W. J. Gillingham, Jr., and V. K. Spicer, at Chicago, and Mr. Gillingham was its first president and Mr. Basford its first secretary. The name was changed to "Railway Signal Association" on November 10, 1903. Its purpose from the first has been the advancement of knowledge concerning the design, construction, maintenance and operation of railway signalling appliances, and this has been so faithfully adhered to that the Recommended Practice and Standards adopted by the Association are in very general use on railroads throughout the country. The headquarters of the Association were at Chicago from 1895 to 1898; at Milwaukee from 1899 to 1902; at New York City in 1903 and 1904, and since 1905 at Bethlehem, Pa.

The present officers are: R. E. Trout, Frisco System, Springfield, Mo., president; C. J. Kellonay, of Wilmington, N. C., and F. W. Pflegin, Omaha, Neb., vice-presidents, and H. S. Balliet, secretary-treasurer.

Ohio Electric Light Association

Mr. Samuel Scovil, president of The Cleveland Electric Illuminating Co., in February, 1895, addressed to each of the electric light companies in Ohio, a letter favoring cooperation in the industry in that State. At a preliminary meeting were present D. L. Davis, of Salem; J. H. Miller, of Springfield; J. Gwynn, of Steubenville; Jerome Penn, of Washington C. H.; B. P. Holmes, of Youngstown; John I. Beggs, of Cincinnati; W. C. Hedges, of Mansfield; E. H. McKnight, of Bowling Green; H. M. Lyman, of Canton; A. W. Field, of Columbus, and Samuel Scovil, of Cleveland. On May 31, 1895, the organization was perfected, with A. W. Field president and Samuel Scovil secretary.

The objects stated in the constitution of the association and steadily adhered to, are to foster and promote the common interests of its members and to advance scientific and practical knowledge in all matters relating to electric light and power companies; to establish cordial and beneficial relations with kindred associations, and also to render such assistance and advice to its members as may not be inconsistent with these purposes. From that small original organization in 1895 it has grown to be the largest State electrical association in the United States. It publishes its own *Monthly,* which not only abstracts the Utility Commission's reports of Ohio, and court decisions affecting electric light and power companies, but is a means of communication between the association and its standing committees. Stated meetings are held in different parts of Ohio throughout the year in which one day is set apart to the consideration of subjects entirely devoted to the work of that standing committee and all employees of companies concerned in that particular branch of work are invited to participate, with results in the betterment of employees and a general raising of the standard of service. Besides the Executive Committee, Advisory

Committee and Finance Committee, the Standing Committees include an Illumination Committee, Meter Committee, Transmission and Distribution Committee, New Business Cooperation Committee, Standardization of Voltages Committee, Insurance Committee, Advertising Committee and Station Operating Committee.

The present officers are: I. L. Oppenheimer, president, of Pomeroy, Ohio; C. H. Howell, vice-president, of Coshocton, Ohio, and D. L. Gaskill, of Greenville, Ohio. Samuel Scovil was secretary, 1895-99, with headquarters at Cleveland; J. H. Perkins was secretary 1899-1900, with headquarters at Youngstown, and D. L. Gaskill has been secretary since that time with headquarters at Greenville.

The Southwestern Electrical and Gas Association

Early in 1895 seventeen of the most prominent gas and electric light men of Texas joined in a call for a meeting which assembled at Houston, May 22, 1895, and organized the Texas Gas and Electric Light Association, with Homer Starr, of Gonzales, Texas, as secretary. Annual meetings were held at Dallas in 1896, and at San Antonio in 1897.

On January, 16, 1898, a jointly called meeting of the Texas Gas and Electric Light Association and the Texas Street Railway Association was held at Austin, and arranged for a joint international meeting, which convened at Laredo, Texas, March 9 to 12, 1898, of these two associations and representatives of the gas, electric light, street railway and power interests of Mexico, at which the association consolidated under the name of the Southwestern Gas, Electrical and Street Railway Association, of which Carl Drake was elected president and E. L. Wells, Jr., secretary. The first annual meeting of this consolidated organization was held at Austin, Texas, May 17 to 19, 1899, at which Thomas D. Miller was elected president, and T. H. Stuart, secretary. A memorable incident of this gathering was a side meeting of forty-four of its members who organized, as its charter members, the now celebrated "Order of the Rejuvenated Sons of Jove," formulating the "ritual" still in use by that now numerous and prosperous order.

J. F. Strickland was elected president at the second annual meeting held at Waco, Texas, 1900, and H. F. Magregor at the third annual meeting at Houston, 1901, T. H. Stuart being continued as secretary. At the fourth annual meeting in San Antonio, 1902, E. H. Jenkins was elected president and Frank Scovill as secretary. The death of the president and the removal from the State of the secretary brought about a temporary disorganization, so that no annual meeting was held in 1903, though the executive committee selected A. E. Judge of Tyler, Texas, as president and Frank Scovill as secretary. Meanwhile another association was organized in Oklahoma under the name of the Southwestern Electrical Association, and a joint meeting was arranged which, convening at Dallas, Texas, April 25 to 27, 1904, under the presidency of A. E. Judge consolidated the two organizations into one under the present name of The Southwestern Electrical and Gas Association. Conventions have since been held annually, and the association has well fulfilled its object to promote the common interests of its members and to advance scientific and practical knowledge in all matters pertaining to electric light, electric power, electric railways, telegraph, telephone and gas companies.

The presidents of the associations have been: A. E. Judge, Tyler, Texas, 1903-4; J. F. Strickland, Dallas, 1904-5; V. M. Phinney, Dallas, 1905-6; H. S. Cooper, Galveston, 1906-7; H. L. Edgar, Fort Worth, 1907-8; R. B. Stichter, Dallas, 1908-9; W. B. Head, Stephensville, Texas, 1909-10; W. B. Tuttle, San Antonio, 1910-11; Joe E. Carroll, Beaumont, 1911-12; Fred M. Lege, Jr., Galveston, 1912-13; George H. Clifford, Fort Worth, 1913-14; Dan. G. Fisher, Dallas, 1914-15; David Daly, Houston, 1915-16; F. R. Slater, Dallas, 1916-17; W. A. Sullivan, Shreveport, 1917-18. The decision of the convention of 1913 to establish a permanent headquarters for the association at Dallas, with a permanent secretary, gave greatly increased strength to the organization, and greatly added to its efficiency as an agency for the welfare of the united electrical and gas interests of Texas. H.

S. Cooper has been secretary of the association since 1913.

The Jovian Order

According to the excellent official manual, the Jovian Order owes its existence to three men, Charles W. Hobson, Charles A. Newning and Sam A. Hobson, who today are known respectively, upon Jovian records as Potentials One, Two and Three, and each of whom in the first struggling years of the Order's existence guided its destiny as Jupiter. To the first named is due the suggestion of the necessity for and possibilities in an organization to promote the success of Texas electrical conventions; to the second, the expansion of that idea and the authorship of the "Basis and Plan" and "Ritual" of the Order; to the third, the practical adaptation of the Plan and the Ritual; to all three and many others of the early members of the Order, the labor incident to its propagation for many years thereafter. The original plans were brought to a definite conclusion, after much discussion and several changes in the working of the idea at first conceived, at a meeting in Austin, Texas, on May 20, 1899, at which Charles W. Hobson presided and Charles A. Newning acted as secretary. Secretary Newning presented as his work, the "Greek Mythological Basis and Plan of the Order of Rejuvenated Sons of Jove," under which a permanent organization was thereby effected.

The first Rejuvenation was held at Waco, Texas, on April 14, 1900, nearly one year after the birth of the Order, with twelve initiates; the second at Houston, Texas, April 19, 1901, with ten candidates; the third and fourth during 1912, representing thirty-seven new members and the first year in which more than one initiation was held.

Due to the fact that the mission of the Order was viewed as principally that of supplying the major entertainment feature for the annual conventions of the Southwestern Gas, Electric and Street Railway Association, but little effort was expended toward increasing the Order's membership other than that evident at those conventions. This is emphasized by the small number of three hundred and seventy-eight, the total membership at the end of eight years. During the ninth year of its existence the Order showed its first material membership increase, amounting to a gain of seven hundred and fifty, bringing the total to eleven hundred and twenty-eight.

The initiation fee as first established amounted to ten dollars (this has never been changed); the annual dues were one dollar, amply sufficing to carry the expense, representing little more than that in connection with the Southwestern Convention Rejuvenations.

Official records of the Order prior to the tenth administration (the fourteenth Jovian year) are either entirely missing or exceeding meager, but, as nearly as it is now possible to establish the facts, increased membership and activity along some channels other than convention entertainment, soon brought a need for strengthening the Order's finances. The necessity for additional funds becoming imperative during the Jovian year of 1907 and 1908, an attempt was made to meet the need by offering to members life membership upon payment of twenty-five dollars. The life membership plan proved inadequate, and at the close of the year during which it was originated, Jovian annual dues were increased to two dollars. The figure decided upon was insufficient, as each succeeding Jupiter found either a deficit at the close of his administration, or, much useful work neglected because of lack of funds, or, both of those conditions. This situation was further aggravated, particularly prior to the tenth administration, by an extraordinarily large number of members delinquent in payment of Jovian dues.

There had been apparent for many years the desire for a more serious note and a demand for constructive labor for the benefit of the Order, its members and the electrical industry. This increased in force and took tangible form at the Ninth Annual Convention in Denver. At that meeting the office of "Assistant to Jupiter," the title held previously, for a period of four years, by the salaried employe in charge of the central office, was abolished. Mercury became an employe as well as an elective officer, and was placed in direct charge of the central office, acting in the capacity of secretary, treasurer and general manager.

A number of other changes, afterwards proving efficacious, were authorized at the Denver meeting, including the establishment of the Past Jupiters' Association Endowment Fund, the decision to solicit advertising patronage actively for "The Jovian" magazine, and the working out of plans given in a "Suggestion Report" submitted to the convention. Immediately following the Denver meeting, the Jovian central office was officially transferred from Chicago to St. Louis, and there ensued a period of intensive development that has never from that moment relaxed.

A careful analysis of Jovian membership statistics made during 1916, showed that nearly sixty per cent of Jovians were holding executive positions in the electrical and allied industries. Among the active membership of 16,000 Jovians were 2,168 presidents and owners of business enterprises, 531 general managers, 507 vice-presidents, 793 secretaries and treasurers, 4,419 department heads, sales managers and purchasing agents, 1,102 engineers, and men holding a great variety of other positions of importance. Included among Jovians are men representing every branch of every division of the electrical field,—Municipal, State and Government offices; Telegraph and Telephone companies; Electric Railway companies; Central stations; Manufacturers; Jobbers; Contractors; Dealers; Engineers; Journalists and Educators.

If the electrical industry failed in every other particular to give The Jovian Order credit for the wonderful development work it has accomplished, it could not deny it the glory of having inspired the electrical league idea, and of being almost solely responsible for its success.

This period includes the conception of the "Degree of Jovian Merit" plan, and its application as a reward for efficient officers. Other constructive measures adopted at that time included the fixing of a certain day each year as "Jovian Day," on which, regardless of other accomplishments, each local officer is required to call his members together for some form of useful entertainment.

The name of "The Order of Rejuvenated Sons of Jove," which the Order had borne since its inception, was found unwieldy and, upon recommendation by the central office, was changed, at the tenth annual convention at Pittsburgh, to "The Jovian Order." At the same time an emblem, embodying the classic head of Jupiter and the words "Co-operation"—"The Jovian Order," was advocated and adopted to be used by those members who objected to the Lucifer design first in effect.

During the eleventh administration (the fifteenth Jovian year) the central office originated and was successful in having accepted by the eleventh annual convention, what is probably the most important single development plan the Order has ever undertaken. This was the authorization of a Jovian "Commercial Division" in connection with the central office, with the expense restricted to an amount not to exceed $2,250 per year. The purpose of the "Commercial Division" is to actively promote the practical, commercially valuable possibilities in the Order, keeping them distinct and separate from the fraternal and social features, without minimizing the importance of the latter. Since its establishment this Division, despite the small expenditure it involved, has accomplished more than any other one element in bringing the Order to be recognized as an essential, constructive factor in the electrical industry.

Other excellent plans developed during the eleventh administration and officially adopted at its close, are: The "Committee of Jovian Goodfellowship" appointed and financed for the relief of worthy, distressed Jovians; the establishment of a "Stentor Degree" for those capable of assisting in the entertainment of Jovian gatherings; and a provision admitting to membership, on a deferred payment plan, students of electrical engineering under the age of twenty-one.

The twelfth administration brought about a redistricting of the United States and Canada with the number of districts and Congressmen increased to fifteen, in addition to Jupiter and Mercury, who were given jurisdiction over all. The title of "Statesmen" was taken from local officers, who were then designated as "First Tribunes" and "Second Tribunes," and given to a new class of officers each having authority over one State or Province.

These changes placed the Order on a much better working basis.

The twelfth administration marked the first work of the "Commercial Division" resulting in: the plan for a Free employment Bureau for Jovians—one that is delivering a needed and valuable service, and is making many stanch friends for the Order; the gathering of useful information relating to and promotion of electrical shows; the preparation for and utilization by Jovians of correspondence courses in electrical engineering, mathematics and salesmanship; the securing of a vast amount of desirable daily press publicity in the interest of the electrical industry; the stimulation of local leagues to engage in civic activity, with the object of holding the interest of their members, and bringing their organizations and their industry into favorable prominence with the public; the inception of an "Efficiency" campaign which will eventually be placed on a par with the "Safety First" plan. This has resulted in the adoption of the slogan "Efficiency Wins!"; a Jovian emblem embodying those words and now used on the letterheads and printed matter of scores of firms; prize contest in "The Jovian," the official organ, for articles on efficiency; and the propagation of the idea in many other forms.

The thirteenth administration (the seventeenth Jovian year) included successful development of all the plans that had previously been justified by results, and the addition of the "Jovian Hotel" project. This secures a hotel discount, to Jovians, of ten per cent, and has been extended to include hotels in more than seventy cities.

The fourteenth administration was not only prolific of results along well-tried lines, but established specifically and incontestably the value of the work of the Order in fostering and federalizing local leagues. The proof was furnished in the exceedingly effective work accomplished by Jovian local organizations in tying in with, and capitalizing into sales, the nation-wide propaganda of The Society for Electrical Development relating to "Electrical Prosperity Week."

This period also resulted in putting into the concrete form of a revised Jovian Constitution a number of highly constructive reforms in Jovian procedure, the need for which had been positively established by several years of investigation and analysis. In addition to the earnest and conscientious effort given the Constitution by the Committee and other members, when presented for action of the Fourteenth Annual Convention at Indianapolis, it was considered in open meeting, clause by clause, and passed only after nine hours of dissection and debate. The more important changes included in the new Constitution are: creation of two classes of Jovian membership—"League" and "Non-League"; chartering and federalizing of Jovian leagues; authorization of a substitute form for the Jovian Ritual; increase in Jovian dues; nomination of elective officers by a committee, and by petition.

The following is a list of all the Jupiters of the Order and the secretaries (Mercury) who served with them:

JUPITER

1st administration, Chas. W. Hobson,
2nd administration, H. F. MacGregor,
3rd administration, S. A. Hobson,
4th administration, C. A. Newning,
5th administration, H. B. Kirkland,
6th administration, W. E. Robertson,
7th administration, J. Robert Crouse,
8th administration, Oscar C. Turner,
9th administration, J. F. Dostal,
10th administration, Robert L. Jaynes,
11th administration, Frank E. Watts,
12th administration, W. N. Matthews,
13th administration, Homer E. Niesz,
14th administration, Thomas A. Wynne,
15th administration, Henry L. Doherty,
16th administration, J. F. Strickland.

MERCURY

1st, 2nd and 3rd Administrations, C. A. Newning.
4th to 7th Administrations, C. B. Roulet.
8th and 9th Administrations, R. M. Van Vleet.
10th to 16th Administrations, Ell C. Bennett.

OHIO SOCIETY OF MECHANICAL, ELECTRICAL AND STEAM ENGINEERS

A call was addressed in 1901 "To Engineers, Steam, Mechanical and Electrical, Shop Superintendents and Managers:

Come and hear some practical talks by practical men, along the lines of advancement in the power plant and factory in general." It resulted in a meeting at the City Hall, Akron, Ohio, at which the Ohio Society of Mechanical, Electrical and Steam Engineers was organized. The objects of the Society are to promote the practice and theory of an economic operation and management of steam power plants and allied sciences connected with engineering both in construction and operation, by means of meetings for social intercourse and the reading and discussion of papers pertaining to mechanical, electrical and steam engineering. Beginning with November, 1908, volume 1, No. 1, the Society has published its transactions in magazine form, thus giving permanent record to its papers and proceedings.

It has helped in legislation in the State along the line of Industrial Education, the establishing of an Experimental Station at The Ohio State University, Inspection of Boilers by the State, and securing more adequate appropriations for the State University for engineering work.

The presidents have been: Elmer E. Miller, 1901-3; R. Hastings Probert, 1903-5; William T. Magruder, 1905-7; Fred W. Ballard, 1907-9; Oscar F. Rabbe, 1909-11; Ed. M. Adams, 1911 to April, 1913 (when he died, the remainder of his term, April to November, 1913, being filled out by H. L. Patterson); William C. McCracken, 1913-15; Joseph L. Skeldon, 1915-16; William E. Haswell, 1916. The secretaries have been: Corwin J. Miller, 1901-6; Fred W. Ballard, 1906-7; W. A. Rowe, 1907-8; David Gaehr, 1908-9; and from 1909 Frank E. Sanborn of The Ohio State University has been secretary-treasurer, Columbus, Ohio.

Vermont Electrical Association

The objects of the State association, organized July 9, 1902, are to foster and protect the interests of those engaged in the commercial production of electricity and to advance a good feeling and better acquaintance spirit among its members.

The presidents of the association have been, successively, Harry Bottomley, Bellows Falls; M. Patterson, Fair Haven; E. D. Blackwell, Brandon; E. E. Gage, St. Johnsbury; Geo. S. Haley, Rutland; E. E. Larrabee, Bennington; F. H. Parker, Burlington; J. E. Davidson, Montpelier; C. E. Parker, Vergennes; F. Barney, Jr., Springfield; C. C. Wells, Middlebury; W. H. Vorce, St. Albans; Wilfred Smith, Woodstock; H. D. Larrabee, Montpelier; I. M. Frost, Rutland; C. C. Wells, Middlebury.

The successive secretaries have been: C. C. Wells, Middlebury; A. B. Marsden, Manchester; C. H. West, Rutland; A. B. Marsden, Rutland, present secretary.

The Empire State Gas and Electric Association

This is an organization of men identified with the commercial production of gas and electric light and power in the cities and towns of the State of New York, formed on February 9, 1905, and since then pursuing its objects of mutual welfare, the interchange of ideas, and united action for the benefit of the common interests of its members in the progress and advancement of its gas and electric industries.

The late W. W. Cole was the first president of the association, and his successors in that office have been, consecutively: E. H. Palmer, W. R. Addicks, M. J. Brayton, R. M. Searle, C. G. M. Thomas, J. T. Hutchings, J. C. De Long, and the present incumbent, Stuart Wilder, of Mt. Vernon, N. Y.

T. R. Beal was the first secretary, who was succeeded by R. A. Davidson, and he by C. H. B. Chapin, now secretary of the association, with offices at 29 West Thirty-ninth Street, New York City.

Western Association of Electrical Inspection

In connection with the administrative and operative side of the electric light and power industry there is no greater need than reliable and uniform inspection service to reduce to certainty the protection afforded against fires due to imperfect wiring and installation of electric service. The Western Association of Electrical Inspectors was organized June 1, 1905, those signing the call being Ed. B. Ellicott, then City Electrician of Chicago; Frank

V. Sackett, then Electrical Inspector Chicago Underwriters' Association; F. D. Varnam, Electrical Inspector, St. Paul, Minn.; Waldemar Michaelsen, then City Electrician of Omaha, Nebraska; and William S. Boyd, then electrical inspector of the Electrical Bureau of the National Board of Fire Underwriters. All of these gentlemen are still living, although Mesrs. Varnam and Boyd are the only ones still in the electrical inspection field.

The Association has wrought valuable achievements in securing greater uniformity in the interpretation of the National Electrical Code. It proposed the establishment of special rules governing theatre wiring; proposed special rules regulating the wiring of electric cranes; proposed the adoption of more uniform and practical rules relating to overhead wiring; stimulated the grounding of transformer secondaries in the Central West; proposed special rules relating to the construction and installation of electric signs; stimulated the use of steel conduit for enclosing wires within the fire limits; restricted the use of wood molding; extended the use of cabinets for enclosing fusible cutouts; assisted in the removal of sub-standard rubber-covered wire in the Central West; operated to bring electrical wiring ordinances up-to-date, and has broadened the views of electrical inspectors included in its membership, which covers the principal cities in the Central Western region of the United States. The Association started agitation in behalf of public safety by appointing a committee on that subject, the chairman of which ultimately took charge of this branch of the work for the United States Bureau of Standards. The headquarters of the Association have always been in Chicago.

The presidents, consecutively, have been F. D. Varnam, Waldemar Michaelsen, E. R. Townsend, George D. Bayle, Fred G. Dustin, V. H. Tousley, W. J. Canada, James Bennett, Ben W. Clark, H. M. Maxwell, F. H. Moore and Emil Anderson.

William S. Boyd, of Chicago, has been the Secretary and Treasurer of the Association from its organization.

Illuminating Engineering Society

Messrs. L. B. Marks, E. L. Elliott and Van Rensselear Lansingh, on December 13, 1905, addressed a joint letter to a list of gentlemen known to be interested in the subject of illumination, suggesting a meeting for December 21, to consider the formation of a society to represent the science and art of illumination. Twenty-five attended that meeting and selected a Committee on Organization composed of L. B. Marks, chairman, and E. C. Brown, E. L. Elliott, Wilson H. Howell, W. S. Kellogg, V. R. Lansingh and W. D. Weaver, to report at a meeting to be held January 10, 1906. At this latter meeting the Society was organized by electing L. B. Marks, President; A. A. Pope and C. H. Sharp, Vice-Presidents; A. H. Elliott, W. S. Kellogg, E. C. Brown, F. N. Olcott, W. D'A. Ryan, and W. D. Weaver, Managers; E. L. Elliott, Secretary, and V. R. Lansingh, Treasurer (all still living).

The first regular meeting of the Society was held February 13, 1906, and about 180 members enrolled prior to that date were designated charter members.

The publications and researches of the Society have contributed in a valuable degree to the knowledge of, and improvement in the lighting field. The Society covers this field from a broad standpoint so as to include not only all methods of light generation, but also all applications of light and illumination. It treats of the artistic, utilitarian and ophthalmological phases of lighting.

Its *Transactions,* periodically published, print papers and discussions on these phases, and the Society also publishes special pamphlets dealing with important special topics, such as: "Light: Its Use and Misuse; "Code of Lighting Factories, Mills and Other Work Places," and various reports of committees of the Society.

Special investigations are made by the technical committees of the Society such as those on Nomenclature and Standards, Research, Lighting Legislation, Education.

A series of lectures (1910) on illuminating engineering, jointly conducted by the Society and Johns Hopkins University, have been published; and a similar volume has recently been published dealing with lectures on the same subject jointly con-

ducted (1916) by the Society and the University of Pennsylvania.

The Society's Committee on Lighting Legislation, after careful research, prepared a code which has been made the basis of regulation of industrial lighting by several States.

In 1915 the Society, through its Committee on Education, proposed outlines of college instruction in illuminating engineering consisting of (a) Complete curriculum for a four-year undergraduate course; (b) Curriculum for a one-year adjunct course; and (c) Curriculum for a one-year post-graduate course.

Reports recently made or in preparation by committees include these subjects: Automobile Headlamps; Railway Vehicle Headlamps; Street Lighting; Diffusing Media; School Lighting; and Lectures to Architectural Students; and another committee prepared popular lectures on Store, Protective and Residence Lighting with accompanying lantern slides, which are designed for circulation among those who wish to present them before organizations interested in this phase of lighting.

During its first year the Society held its meetings in an auditorium of the New York Edison Company, but since 1907 it has had its headquarters in the United Engineering Societies Building in New York. Its growth has led to the organization of five sections of the Society each of which holds regular monthly meetings open to all members of the Society, resident or visiting; the New York, Philadelphia, Pittsburgh, New England, and Chicago Sections.

The presidents of the Society have been consecutively: L. B. Marks, 1906; C. H. Sharp, 1907; Louis Bell, 1908; W. H. Gartley, 1909; E. P. Hyde, 1910; A. E. Kennelly, 1911; V. R. Lansingh, 1912; Preston S. Millar, 1913. After that, the fiscal year being changed to October, the presidents were: C. O. Bond, 1913-1914; A. S. McAllister, 1914-1915; C. P. Steinmetz, 1915-1916; William J. Serrill, 1916-1917, and G. H. Stickney, 1917-1918.

The general secretaries have been A. H. Elliott, 1906; V. R. Lansingh, 1907-1908; Preston S. Millar, 1909-1912; J. D. Israel, 1913; C. A. Littlefield, 1914-1916; G. H. Stickney, 1916-1917; Clarence L. Law, 1916-1918.

Wisconsin Electrical Association

The Wisconsin Electrical Association is a consolidation formed in 1909 of two previously existing societies—the Wisconsin Electric and Interurban Railway Association and the Northwestern Electrical Association, the latter representing electric light and power interests.

The Wisconsin Electric and Interurban Railway Association was organized October 29, 1906, by Clement C. Smith, of Milwaukee, F. W. Montgomery of Madison, Ernest Gonzenbach of Sheboygan, and N. C. Draper of Fond du Lac, Wis., all of whom are still living. Henry D. Smith of Appleton was the first president of the Association (1906); B. L. Parker of Green Bay, 1908; and Clement C. Smith of Milwaukee, 1909. In the latter year a joint meeting held June 28 and 29 merged the two associations as the Wisconsin Electrical Association which has since been an active organization in behalf of the electric railway, electric power, and electric light interests of Wisconsin. The presidents successively have been Ernest Gonzenbach, Sheboygan, Wis.; Clement C. Smith, Milwaukee; George B. Wheeler, Chippewa Falls; Irving P. Lord, Waupaca; William H. Winslow, Superior; P. H. Korst, Janesville; M. C. Ewing, Wausau; W. E. Haseltine, Ripon; B. F. Lyons, Beloit, and John St. John, Madison.

Clement C. Smith was the first Secretary. He was succeeded by J. S. Allen, George Allison, and he by J. P. Palliam, the present secretary and treasurer. The Association is affiliated with the National Electric Light Association.

Association of Iron and Steel Electrical Engineers

Many of the ramifications of electrical engineering present highly specialized problems of technical treatment and practice the solution of which can be aided and simplified through discussion and research by organization of those directly interested in that special field.

Such an organization is the Association

of Iron and Steel Electrical Engineers, organized in 1907 by J. F. Chapman, Palmer Collins, H. A. Cox, R. B. Davenport, James Farrington, J. F. Jelley, D. J. Jones (now deceased), O. R. Jones, F. R. Kittredge, A. T. Koehler, H. M. Latham, H. A. Lewis, G. E. McFeaters, R. W. McGarvey, F. W. McKee, L. R. Palmer, A. Patterson, J. R. Reed, G. W. Richardson, R. R. Shepherd, W. M. Snyder, F. W. Stevens (now deceased), G. W. Sturgess, James Watters, G. R. Winslow, F. H. Woodhull, A. J. Woodworth and E. W. Yearsley.

The object of the organization was the advancement of the application of electricity to the iron and steel or allied industries by the co-operation of its members, by means of periodical meetings for the written presentation of professional papers, the discussion of pertinent subjects and the publication of such papers and discussions as may seem expedient. The wide-spread national propaganda known as the Safety First or Accident Prevention movement had, it is said, its inception with this Association. The Association has aimed to co-operate with State authorities in efforts to cope with industrial hazards, giving endorsement to beneficial legislation and presenting intelligent and authoritative opposition to vicious legislation as it applies to iron and steel and allied industries. It plans to co-operate with manufacturers in the safety features of design or equipment, and to co-ordinate the efforts of the members toward safe installation and operation.

It has done excellent work in the standardization of equipment of different manufacturers, one with another and to secure uniformity of design and practice; and it is active in fostering the training of apprentices and industrial training in general.

The permanent headquarters of the Association are at Pittsburgh, Pa. James Farrington was its first president, 1907-8; followed by J. C. Reed, 1909; F. P. Townsend, 1910; L. R. Palmer, 1911; B. R. Shover, 1912; C. W. Parkhurst, 1913; E. Friedlaender, 1914, C. R. Jones, 1915; W. T. Snyder, 1916; F. D. Egan, 1917; C. A. Menk, 1918; D. M. Petty, 1919. The first secretary was E. W. Yearsley, 1907; then G. H. Winslow, 1908; James Farrington, 1909-1913; W. T. Snyder, 1914-1915; W. O. Ochsmann, 1916, and John F. Kelly, 1917 to date.

Missouri Association of Public Utilities

J. P. Casey, then of the Commercial Electric Supply Company of St. Louis, but now of the Western Electric Company of St. Louis, addressed in 1907 a letter to various representatives of electrical and other public utility interests in Missouri suggesting organization for promoting mutual interests and progress. On October 21, 1907, fourteen persons, representing as many Missouri cities, answered the call and organized the Missouri Electric Light, Gas and Street Railway Association, since changed to Missouri Association of Public Utilities. The Association has devoted its efforts to the education of its members relative to the delivery of service to the public by the utilities, to which has been added, in recent years the familiarizing of members with the laws and rulings of the Public Service Commission. The headquarters of the Association are at St. Louis.

Dr. D. J. Porterfield of Cape Girardeau was the first president, 1907-1908. His successors have been W. B. Hays, Poplar Bluff, Mo., 1908-1909; W. A. Bixby, Springfield, Mo., 1909-1910; R. J. Irvine, Marshall, Mo., 1910-1911; J. E. Murray, Louisiana, Mo.; 1911-1912; P. A. Bertrand, Jefferson City, 1912-1913; J. E. Harsh, Sedalia, 1913-1914; A. C. Einstein, St. Louis, 1914-1915; G. E. Hayler, Joplin, 1915-1916; H. Wurdack, 1916-1917; Bruce Cameron, 1917-1918; J. H. Van Brunt, 1918-1919. The Secretaries have been C. Z. Pierson, St. Charles, 1907-1908; C. L. Clary, Sikeston, 1908-1910; N. J. Cunningham, Springfield, Mo., 1910-1912; P. W. Markham, Brookfield, 1912-1913; and since 1913 F. D. Beardslee has been Secretary and Treasurer of the Association.

Indiana Electric Light Association

The Indiana Electric Light Association was formed in 1908 "for promoting the welfare and improvement of electric light and power service and co-operation of its

members in securing more complete knowledge, both scientific and practical, relating to electric light and power service." The headquarters of the Association have been at the office of its Secretary, first at Muncie, Ind., where Fred C. Leslie, the first secretary resided. He died and J. V. Zartman of Indianapolis became his successor until 1914, when Thomas Donohue of Lafayette, Ind., (the present incumbent), became Secretary, the office being located there ever since.

The first President was T. C. McReynolds of Kokomo and his successors, consecutively, have been C. C. Perry of Indianapolis; F. A. Bryan of South Bend; J. W. Robb of Clinton; T. F. English of Muncie; T. F. Grover of Terre Haute; E. J. Condon of Angola; S. W. Greenland of Fort Wayne, and the present president, J. A. Wynne, of Indianapolis.

Pennsylvania Electric Association

The Pennsylvania Electric Association, which was organized at Harrisburg, Pa., January 15, 1908, is the State Branch of the National Electric Light Association. It was formed to foster and promote the common interests of its members, and to advance scientific and practical knowledge in all matters relating to electric light and power companies; also to establish cordial and beneficial relations with kindred associations and between manufacturers of electrical machinery and appliances and the members of the Association. The first officers of the Association were L. H. Conklin (of Scranton), President, 1908-1909; E. F. McCabe, Vice-President; W. P. Powers, Secretary-Treasurer, and E. H. Davis and A. P. Granger, members of the Executive Committee.

Mr. Conklin's successors in the office of President have been: E. L. Smith, Towanda, 1910; A. R. Granger, Chester, 1911; R. S. Orr, Pittsburgh, 1912 (deceased); Van Dusen Rickert, Pottsville, 1913; Duncan T. Campbell, Scranton, 1914; Walter E. Long, Philadelphia, 1915; Stephen C. Pohe, Bloomsburg, 1916; and George B. Tripp, Harrisburg, 1917; H. N. Muller, 1918, and Thomas Sproule, 1919.

The offices of Secretary and Treasurer were combined until 1915, Mr. W. P. Powers serving in 1908; E. L. Smith, 1909; Van Dusen Rickert, 1910-1911; Walter E. Long, 1912-1913; Stephen C. Pohe, 1914; H. N. Muller, Pittsburgh, 1915. Henry M. Stine of Harrisburg has been Secretary from 1916.

The Electric Power Club

Mr. S. L. Nicholson, traveling over the country as representative of the Westinghouse Electric and Manufacturing Company, and meeting many manufacturers and others interested in the electrical industry, became impressed with the need for standardization of usage and practice in the electrical power industry, and of an organization of motor manufacturers to achieve that end, and found on consulting several of them that such an organization could be effected.

At his suggestion a preliminary gathering met in New York City in March, 1908, at which Anson W. Burchard, A. L. Doremus, F. S. Hartman, Charles W. Holtzer, C. F. McGilvary, S. L. Nicholson and L. A. Osborne were present. From this gathering there resulted a meeting at Hot Springs, Virginia, on June 1, 1908, at which representatives from twenty-five manufacturing companies were present, and on June 2 the constitution and by-laws were adopted and an organization formed under the name of the American Association of Electric Motor Manufacturers, with S. L. Nicholson, President; C. F. McGilvary, R. J. Russell, and F. S. Hunting, Vice-Presidents; J. C. McQuiston, temporary Secretary and Treasurer and James Burke, A. L. Doremus, J. W. Ham, J. C. Hobart, Charles W. Holtzer, B. C. Kenyon, W. A. Layman, C. H. Roth, and A. H. Whiteside, members of the Executive Committee. The Association held meetings in St. Louis, November, 1909; Hot Springs, Va., May, 1910, and Pittsburgh, Pa., October, 1910.

During the winter of 1910-1911 two of the important company members of the Association withdrew from the Association and with it a considerable financial support which was vitally necessary for work that was being done, and many of the other members felt that the good work being done might be entirely lost. Therefore a call was made for a meeting to be

held in Chicago, November 2, 1910, to consider ways and means of continuing the Association. At that meeting a new form of organization was adopted under which "The Electric Power Club" was formed, with J. C. Hobart, President; W. A. Layman, Vice-President; E. R. Harding, Treasurer, and C. H. Roth, Secretary. Mr. Hobart continued as president 1910-1913, succeeded by Professor F. B. Crocker, 1913-1915, E. R. Harding, 1915-1917, and C. L. Collens, 2nd. C. H. Roth has been the Secretary-Treasurer of the Club from its organization. The Secretary's office is at 1410 West Adams Street, Chicago. Meetings have been held in the spring and fall of each year, the annual meeting being held in May or June.

The principal achievement of the Electric Power Club is the creation of Standardization Rules which represent the adopted practice of many manufacturers, and especially the standard speed ratings which are used to a great extent by most motor manufacturers. The Club has brought together the principal executives and engineers of the electrical apparatus manufacturers and given them a chance to find out that their competitors (to use the expression of a member) "do not have horns." These acquaintances promote fairness of commercial practice, and have furnished the basis for a vast amount of engineering, manufacturing and commercial information which has had favorable effect on the growth of the electrical apparatus industry.

Since its organization the Electric Power Club has grown from sixteen member companies to fifty-five. It has been instrumental in bringing about close working co-operation between the various associations that represent the great electrical industry. By means of the Electrical Manufacturers Council and the Committee for Co-operation on Technical Subjects (in the formation of which The Electric Power Club took an important part), the electrical industry is furnished with a bond which will allow its members to work together as a unit whenever the occasion demands it.

The Club issues standardization booklets and various bulletins on subjects of interest to those identified with the manufacture of electrical apparatus.

Arkansas Association of Public Utility Operators

On September 17, 1908, Messrs. W. C. McGuire of Arkadelphia; D. L. Ellis of Camden; C. J. Griffith and D. A. Hegarty of Little Rock; J. W. Hewitt of Marianna; and B. C. Fowles of Pine Bluff met and organized the Arkansas Association of Public Utility Operators, for the purpose of advancement of the interests of its members and the public utility business in the State of Arkansas. Its membership includes the corporations engaged in the generation and distribution of electric light and power for domestic and industrial use, electric traction companies, and gas manufacturing corporations, in that State.

The Presidents of the Association have been D. A. Hegarty, 1908-1909; B. C. Fowles, 1909-1911; J. M. Hewitt, 1911-1912; J. W. McClendon, 1912-1913; J. W. Gillette, 1913-1914; C. J. Griffith, 1914-1915; H. C. Couch, 1915-1916; W. J. O'Brien, 1916-1917. The Secretaries have been J. E. Cowles, 1908-1910; W. J. Tharp, 1910-1915; and R. B. Fowles, 1915-1916; and W. J. Tharp since 1916.

Alabama Light and Traction Association

A preliminary meeting was held on October 23, 1908, and a permanent organization was effected on November 23, 1908, of the Alabama Light and Traction Association. The purposes of the organization are expressed as being the establishment of a spirit of co-operation among members; the encouragement of friendly relations between the companies and the public; the discussion and recommendation of methods of construction, management and operation of gas and electric lighting plants, and street and interurban railways, and of safeguarding their interests.

The successive Presidents of the Association have been A. H. Ford, Birmingham, 1908-1909; J. H. Wilson, Mobile, 1909-1910; R. L. Rand, Anniston, 1910-1911; C. E. White, Montgomery, 1911-1912; C. C. Henderson, Greenville, 1912-

1913; R. L. Ellis, Selma, 1913-1914; J. P. H. de Windt, Birmingham, 1914-1915; F. H. Chamberlain, Birmingham, 1915-1916; C. C. Henderson, Greenville, 1916-1917.

The Secretaries of the Association have been Lloyd Lyons, 1908-1910; George S. Emery, 1910-1912; H. O. Hanson, 1912-1915; all of Mobile, and J. P. Ross of Birmingham since 1915.

Public Service Association of Virginia

The Public Service Association of Virginia, composed of electric railways, light and power, water and gas companies, doing business in the State of Virginia, was organized in the City of Richmond on December 8, 1908. The original officers were E. C. Hathaway, President; Henry W. Anderson, R. D. Apperson and J. F. Rison, vice-presidents; H. M. Darnall, Secretary and Treasurer. The objects named in the constitution, toward which the Association has continuously worked, are: The promotion and advancement of knowledge, both scientific and practical, in all matters relating to the business interests of the members; the creation and promulgation of a friendly interest in each other's welfare; the protection by all reasonable and fair means of the interests of the Association; to foster and encourage more friendly and cordial relations between its members, patrons, and the various city and county authorities from whom the franchise rights of its members are obtained; and to encourage and promote, among its members, a determination to constantly improve the service of the various companies.

E. C. Hathaway served as President until July, 1912; J. W. Hancock from July, 1912, to August, 1915; E. M. Funkhouser from August, 1915, to August, 1916, when J. N. Shannahan succeeded to the presidency of the Association.

H. W. Darnell served as Secretary until September, 1911; F. Von Schilling from September, 1911, to June 1, 1912; and since July 1, 1912, W. J. Kehl has been Secretary.

Radio Club of America

The "Junior Wireless Club" was founded in New York City, January, 1909. The members at that time were men actually engaged in amateur wireless activity. The object of that club was to stimulate activity and organization in amateur circles and to take a firm stand against unfair and hasty legislation. The Club was and still is active in the endeavor to protect amateur wireless work from becoming extinct through the over-zeal of lawmakers.

In October, 1911, the name of the body was changed to the Radio Club of America. Meetings were held monthly when members would read more or less informal papers on new and interesting tests or advancements in the art. Occasionally an outsider would address the Club. For three years or more the monthly meetings have been held in Columbia University. The papers read have been those calculated to interest all radio men without going into the commercial side of the subject. Beginning in 1910 the *"Proceedings"* have been published monthly and distributed to members; and they also appear in the magazine "QST." The Club has also prepared a book on the latest advances in radio, which amounts practically to an advanced textbook.

The Presidents to date have been: W. E. D. Stokes, 1909 to 1911; Frank King, 1912-1914; George J. Eltz, Jr., 1915; Edwin H. Armstrong, 1916-1918.

The Secretaries have been: Frank King, 1909-1911; George Burghard, 1912-1913; David S. Brown, 1914-1916; Thomas J. Styles since 1917.

Electric Vehicle Association of America

What was formerly the Electric Vehicle Association has been, since March, 1916, the Electric Vehicle Section of the National Electric Light Association, but a brief statement of the former association serves to explain the origin and development of activities that continue uninterruptedly under the new organization.

On May 6, 1910, Mr. Arthur Williams invited to his office several electric vehicle men, stating that the purpose of the meeting was to discuss the desirability of forming an association for the object of co-operation in the endeavor to help the public to a better understanding of the improved electric car. The original proposition was

to form an association that should be local only, but when the subject came up for discussion at the annual convention of the National Electric Light Association it was decided to make the organization national in scope, with the Electric Vehicle and the Central Station Association as a local branch, and that there should be provision made for formation of other local branches in other centers of activity. At a larger meeting in Mr. Williams' office on June 8, 1910, it was decided to form the Electric Vehicle Association of America. The Association was incorporated under the laws of New York on August 28, and formally organized on September 1, 1910, by the election of William H. Blood, Jr., as President; Arthur Williams, Vice-President; C. E. Firestone, Secretary, and Harvey Robinson, Treasurer and Assistant Secretary. At the first convention, October 18, 1910, there were present nearly three hundred delegates and representatives from central stations, electric vehicle, storage battery and allied interests. The actual membership at that date was about fifty. In November, 1910, the New England Section was added.

The Association launched into a very vigorous and fruitful advertising of the merits of the electric vehicle for commercial and passenger purposes. An official paper, "The Central Station," was adopted. The annual meetings grew in interest, the membership enlarged until it numbered twelve hundred, and the efforts of the Association brought large returns in the growing appreciation of the electric vehicle. Finally it was decided to become an integral part of the National Electric Light Association. Local sections had meanwhile been established in Chicago, Philadelphia, Washington, Cincinnati, San Francisco, Los Angeles, Pittsburgh, New York, Detroit, Cleveland, Toronto, Denver and St. Louis, Kansas City, Portland, Ore., and Western New York.

The Presidents of the Association were William H. Blood, Jr., 1910-1912; Arthur Williams, 1912-1913; Frank W. Smith, 1913-1914; John F. Gilchrist, 1914-1915; W. H. Johnson, 1915-1916. E. S. Mansfield became chairman of the Electrical Vehicle Section of the National Electric Light Association.

The Secretaries were C. E. Firestone, 1910-1912; Frank W. Smith, 1912-1913; Harvey Robinson, 1913-1914; A. Jackson Marshall, 1914-1916, and Mr. Marshall continued as Secretary of the organization transformed into the Electric Vehicle Section of the National Electric Light Association.

The Tri-State Water and Light Association of the Carolinas and Georgia

This Association was organized on June 28, 1911, at Columbia, South Carolina, the promoters being W. F. Stieglitz and F. C. Wyse of Columbia; A. J. Sproles of Greenwood, S. C., and J. W. Neave of Salisbury, N. C. These gentlemen served the Association as President in the order named, Mr. Neave being succeeded in 1916 by E. M. Anderson of Abbeville, S. C., and he by J. E. Guilford of Macon, Ga., in 1917. The secretaries consecutively have been, J. W. Neave of Salisbury, S. C.; J. G. Barnwell of Rock Hill, S. C.; F. C. Wyse of Columbia, S. C.; and W. F. Stieglitz of Columbia, the present incumbent.

The organization has served a useful purpose in promoting efficiency in public utility service. The annual meetings have proved to be of much benefit to the members and to the communities they represent. The electric developments and improvements receive attention each year and prominent displays are made by manufacturers of electrical supplies.

Oklahoma Utilities Association

In 1911 five Oklahoma engineers organized the Gas, Electric and Street Railway Association of Oklahoma.

The Presidents consecutively have been: Noel R. Gascho, 1911; Fred Caldwell, 1912; F. E. Bowman, 1913; Geo. W. Knox, 1914; W. J. Dibbens, 1915; C. H. Kretz (Okmulgee), 1916; F. D. Shaffer, 1917. H. V. Bozell was Secretary 1911-15, and L. W. W. Morrow 1916-1917.

During the summer of 1918 the Gas, Electric and Street Railway Association and the Oklahoma Utilities Bureau were merged into the Oklahoma Utilities Association with the same officers as the former Association.

The Oklahoma Utilities Association is composed of seven bureaus, namely, those dealing with gas, electricity, water, street railways, telephones, pipe lines, manufactures and supplies.

The President is J. F. Owens, Manager of Oklahoma Gas & Electric Co., Oklahoma City, and H. A. Lane, Oklahoma City, is Secretary.

The Association has attracted to its membership the executives and representatives of the public utilities of Oklahoma; has unified the legislative policies of Oklahoma utilities and brought its influence to bear in securing the passage of just and equitable utility legislation; and has furnished data for various state legislative and tax boards. It has also been the clearing house for the ideas and problems of utility operators in Oklahoma.

The Institute of Radio Engineers (Incorporated)

The only society representing the radio engineering profession is The Institute of Radio Engineers. Previous to its organization, two of the most influential organizations in the radio field were the Society of Wireless Telegraph Engineers, of Boston (established 1907), with 43 members on January 1, 1912, and the Wireless Institute of New York (established 1909), with 27 members on that date. It was determined to consolidate these two and on May 13, 1912, The Institute of Radio Engineers was formally established with a membership of 45. Its membership has steadily increased until it now numbers over one thousand.

The Institute has succeeded in drawing up Standardization Specifications and definitions of terms which have been accepted, practically universally, in the radio field, even abroad. Much of the growth on the engineering side of the subject is due to the Institute, inasmuch as the only engineering publication in the English language on the subject is the "Proceedings of the Institute of Radio Engineers," issued bi-monthly and containing valuable papers and discussions of the problems and progress of radio engineering. This publication as well as the *Year Book* and various reports of value to the profession, are edited with skill and scientific accuracy by Professor Alfred M. Goldsmith, Ph.D., of the College of the City of New York. Meetings of the Institute are held monthly in New York, except during July and August of each year. At these meetings, scientific, engineering and other papers relative to the art of radio communication are presented by members of the Institute, specially qualified to treat the subject. The presentation of the papers is followed by an open discussion. Sections of the Institute have been established in January, 1914, in Washington, D. C.; at Boston, Mass., in November, 1914; at Seattle, Washington, February, 1915, and at San Francisco in 1916. These sections also hold regular meetings with papers and discussions, many of which have appeared in the "Proceedings." The annual meeting of the Institute is held at New York in the month of January.

The Presidents of the Society of Wireless Telegraph Engineers were John Stone Stone, 1907-1908; Lee De Forest, 1909-1910; and Fritz Lowenstein, 1911-1912. Robert H. Marriott was President of the Wireless Institute from 1909-1912, and was the first President of The Institute of Radio Engineers in 1912. He was succeeded by Greenleaf W. Pickard, 1913; Louis W. Austin, 1914; John Stone Stone, 1915; Arthur E. Kennelly, 1916; Michael I. Pupin, 1917, and George W. Pierce, 1918. Dr. Alfred Goldsmith is Secretary of the Institute.

The Society for Electrical Development, Incorporated

The Society for Electrical Development was a natural outgrowth of the rapid rise and spread of the electrical industry. New applications of electricity multiplied so fast that only those professionally interested could keep up with them. Many valuable inventions were slow in attaining popularity simply because those who needed them did not know about them. New electric ways of doing things better were not employed because those who were doing them in the old way did not know about the new.

The need of educating the public to a greater appreciation of the advantages of electricity, and the education of the men in the industry to a greater appreciation of the opportunities for more business and

how to secure it, were the impelling reasons for the organization and incorporation of The Society for Electrical Development, which is aptly described as "a corporation for co-operation." The original Organization Committee consisted of Henry L. Doherty, W. H. Johnson, John F. Gilchrist, A. C. Einstein and J. E. Montague, representing the Central Stations; A. W. Burchard, L. A. Osborne, W. A. Layman, B. M. Downs, and J. Robert Crouse, representing the manufacturers; W. E. Robertson, Frank S. Price, W. W. Low, Gerard Swope and Roger Scudder, for the jobbers; and Ernest Freeman, Earnest McCleary, J. R. Strong, G. M. Sanborn, and P. N. Thorpe, for the contractors, all of whom are still living, with the exception of A. C. Einstein and Roger Scudder. Henry L. Doherty is now President of the Society. The first Secretary was Philip S. Dodd, who was succeeded by Stephen L. Coles, and he by James Smieton, Jr., the present incumbent. James M. Wakeman is General Manager.

One of the most important activities of the Society has been bringing into closer co-operation the public utilities in the electrical field with the great public which they serve, with a consequence of higher appreciation on the part of the public of the services rendered by central stations and others engaged in the electrical industry.

The education of the public has been carried on through the medium of the daily newspapers, popular magazines, trade and technical press, motion pictures, lectures, pamphlets; and through great sales campaigns, such as Electrical Prosperity Week in 1915, America's Electrical Week, in 1916, and the Annual Spring Housewiring campaigns.

The education of the men of the industry has been carried on through a staff of experts, addressing electrical conventions; preparing booklets outlining campaigns and monthly window display service, booklets for salesmen, advertising copy, etc., and improved relations between the public utilities and their customers have been brought about through articles in the daily press, and through the regular service established by the Society, and rendered without charge to a select list of newspapers throughout the country. The Society has done a vast amount of successful missionary work from its permanent text of "Do It Electrically."

New Mexico Electrical Association

In 1914, C. M. Einhart, of the Roswell Gas and Electric Company, started out to get the Central Station men of New Mexico together for mutual benefit and progress. He secured the aid of H. Alex. Hibbard, of the Electric Appliance Company of Chicago, and of A. F. Van Deisne of the Albuquerque Gas and Electric Company. By much correspondence and personal effort they secured a well-attended meeting in Albuquerque in February, 1915, at which nearly all the Central Stations in the State were represented and a goodly number of supply men were present. The New Mexico Electrical Association was formed, with twenty-eight central stations and twelve or more associate members. C. M. Einhart was elected President and E. A. Thiele of Roswell became Secretary.

The Association has been very successful in creating a closer affiliation with all Central Stations and has aided materially in standardizing and other operating details. Conventions of the Society are held in Albuquerque in the early part of the year.

Mr. Einhart was succeeded in the Presidency by W. P. Southard of Albuquerque and J. R. Smith of Raton. Chas. E. Twogood is the Secretary-Treasurer of the Society.

South Dakota Electric Power Association

The South Dakota Electric Power Association was organized in February, 1916, along the lines common to the Central Station associations throughout the country. Its first president was Robert Ferris of Yankton, South Dakota, and its first secretary was A. H. Savage of the Dakota Light and Power Company.

The Association has had valuable data presented to it in regard to losses on iron wire transmission, derived from observations on the lines of the Dakota Light and Power Company, gathered and presented by Professor W. T. Ryan, of the University of Minnesota.

ELECTRICAL SOCIETIES

(COMMERCIAL)

There are various organizations connected with commercial relations to the electrical industry, such as credit organizations, electrical contractors' associations, jobbers' associations and associations producing and handling products used in connection with electrical work. Some of these may here be briefly referred to:

NATIONAL ASSOCIATION OF ELECTRICAL CONTRACTORS AND DEALERS

The National Electrical Contractors' Association of the United States was organized in Buffalo, N. Y., July 17, 1901. Its objects are the standardization of everything electrical, co-operation among its members for the dissemination of electrical data and information on electrical appliances and material. It has members in every section of the United States, with several State associations affiliated with it, and has committees working on all subjects of vital interest to electrical contractors and dealers.

Its successive Presidents have been Charles L. Eidlitz, 1901-1903; Earnest McCleary, 1903-1905; James R. Strong, 1905-1908; Gerry M. Sanborn, 1908-1910; Marshall L. Burnes (now deceased), 1910-1912; Ernest Freeman, 1912-1914; John R. Galloway, 1914-1916; Robley S. Stearnes, 1916-1918. The first Secretary was W. H. Morton, who held the office until September, 1913, and was succeeded by George H. Duffield, who served as Secretary, Business Manager and Editor of the journal of the Association until April 1, 1917, when he resigned and was succeeded in those capacities by Harry C. Brown.

In October, 1917, the name of the Association was changed to the National Association of Electrical Contractors and Dealers, and the constitution so amended that the organization was enabled to take in all classes of retailers of electrical merchandising as well as electrical contractors. At that time Mr. W. Creighton Peet of New York City was elected National Chairman and still holds the office.

In September, 1918, W. H. Morton again took charge of the activities of the organization with the title of General Manager, and the offices of the Association are now located in New York City at 110 W. 40th Street.

Twenty-three State Associations are now organized as given below, with the names of the Chairman and Secretary of each:

ALABAMA

Chairman—J. R. Wilcox, 112 N. 24th St., Birmingham.

Secretary—T. G. Erwin, 512 Broad St., Gadsden.

ARKANSAS

Chairman—J. R. Bloom, 219 W. 2nd St., Pine Bluff.

Secretary—J. C. Dice, 112 E. 4th St., Little Rock.

CALIFORNIA

Chairman—E. E. Brown, 245 Minna St., San Francisco.

Secretary—J. Redpath, 505 Rialto Bldg., San Francisco.

CONNECTICUT

Chairman—E. S. Francis, 168 Pearl St., Hartford.

Secretary—Geo. M. Chapman, 43 E. Main St., Waterbury.

GEORGIA

Chairman—T. H. McKinney, Peters Bldg., Atlanta.

Secretary—Dan Carey, Chamber of Commerce Bldg., Atlanta.

KANSAS

Chairman—R. M. Sutton, 125 N. Market St., Wichita.

Secretary—H. S. Lee, 816 Kansas Ave., Topeka.

ILLINOIS

Chairman—J. A. Weishar, Rock Island.

Secretary—G. A. Engelken, 55 W. Harrison St., Chicago.

INDIANA

Chairman—A. L. Swanson, 404 Main St., Evansville.

Secretary—Geo. S. Skillman, 29 S. Capitol Ave., Indianapolis.

IOWA

Chairman—J. E. Sweeney, 25 Bridge St., Waterloo.

Secretary—F. Bernick, Jr., Oskaloosa.

LOUISIANA

Chairman—C. S. Barnes, 513 Gravier St., New Orleans.

Secretary—Gabe Correjolles, 511 Poydras St., New Orleans.

MARYLAND

Chairman—S. C. Blumenthal, 505 N. Eutaw St., Baltimore.

Secretary—John S. Dobler, Baltimore.

MASSACHUSETTS

Chairman—A. J. Hixon, 246 Broad St., Boston.

Secretary—J. E. Wilson, 263 Summer St., Boston.

MICHIGAN

Chairman—L. R. Greusel, 21 Jefferson Ave., Battle Creek.

Secretary—Bruce W. Palmer, 60 Park Pl., Detroit.

MINNESOTA

Chairman—W. I. Gray, 914 Mary Pl., Minneapolis.

Secretary—Roy Constantine, Builders Exch. Bldg., Minneapolis.

MISSOURI

Chairman—Fred B. Adam, 914 Pine St., St. Louis.

Secretary—W. F. Gerstner, 120 N. 2nd St., St. Louis.

NEW JERSEY

Chairman—C. R. Newman, 17½ Howe Ave., Passaic.

NEW YORK

Chairman—J. J. O'Leary, 20 Broadway, Buffalo.

Secretary—J. P. Ryan, 26 Cortlandt St., New York City.

OHIO

Chairman—A. L. Oppenheimer, 6507 Euclid Ave., Cleveland.

Secretary—Geo. D. Bury, the Builders Exch., Cleveland.

OKLAHOMA

Secretary—W. W. McMichaels, Tulsa.

OREGON

Chairman—J. R. Tomlinson, 286 Oak St., Portland.

Secretary—J. W. Oberender, DeKum Bldg., Portland.

PENNSYLVANIA

Chairman—A. Gentel, 1503 Columbia Ave., Philadelphia.

Secretary—M. G. Sellers, 1518 Sansom St., Philadelphia.

TENNESSEE

Chairman—P. W. Curtis, Chattanooga.

Secretary—J. A. Fowler, 10 S. Second St., Memphis.

WASHINGTON

Chairman—V. S. McKenny, Armour Bldg., Seattle.

Secretary—Forrest E. Smith, 205 Boston Block, Seattle.

WISCONSIN

Chairman—R. J. Nickles, 120 S. Hamilton St., Madison.

Secretary—J. A. Piepkorn, 11 Wells St., Milwaukee.

As a part of the State Association, local organizations have been formed in the various cities of the country, and these associations are being rapidly extended.

OREGON ASSOCIATION OF ELECTRICAL CONTRACTORS AND DEALERS

This Association was organized on February 9, 1916, and has since been conducted along educational lines and co-operative principles, and has proved an important factor in bettering conditions electrically in the State of Oregon. It stands for co-operation with the National Fire Protective Association and the Society for Electrical Development, and includes in its membership central stations, municipal light and power plants, telephone companies and electric railroad companies, as well as contractors and dealers. F. C. Green is President and J. W. Oberender Secretary of the Association.

NATIONAL ELECTRICAL CREDIT ASSOCIATION

This Association was organized at a meeting held in Cincinnati, Ohio, October 7, 1898, under the name of the National Electrical Trades Association by representatives of the Electrical Trades Society of New York, Electrical Trades Association of Philadelphia, Electrical Trades Association of Chicago, New England Electrical Trades Association, and Electrical

Trades Association of Cincinnati. The first President was R. E. Gallaher of New York, and the first Secretary and Treasurer of the Association was Frederic P. Vose, who has served continuously in that capacity ever since, with headquarters in the Marquette Building, Chicago. Charles C. Hilles of San Francisco is now President of the Association.

The Association was incorporated under the laws of Illinois, and later its name was changed to the National Electrical Credit Association. The objects for which it was formed are to promote a more cordial feeling among its members; to protect their mutual interests; to secure uniformity and certainty in the customs and usages of electrical trade and commerce; to settle differences among its members wherever possible; to collect trade information and distribute it among its members and to save them from making unsatisfactory credits.

The five local Associations which joined in organizing the National Association remain as affiliated members of the National body. These changed their names from "Trades" to "Credit" associations. The Cincinnati Association was merged with the Chicago Association in 1904, and in 1902 the Electrical Credit Association of the Pacific Coast was organized, with headquarters in San Francisco.

The National Association forms a central office or bureau for the interchange and dissemination between the associations of ledger facts and credit experiences of the individual members of the five local associations, and a *Monthly Bulletin* is issued by the national body, containing the names of delinquent customers reported by the individual members of the local associations. The *Bulletin* is for the exclusive and confidential use of members only. The Association also publishes and distributes to the six hundred and more members *The Viewpoint*, a monthly paper edited by the Secretary.

The Electrical Manufacturers' Club

The original Electrical Manufacturers' Club was organized in the fall of 1905 "to assist by discussion and recommendations in establishing and maintaining harmonious relations between the manufacturers of electrical supplies and the jobbing and contracting interests throughout the country, and at meetings of the Club to be called at various intervals to exchange ideas, obtain information with reference to the distribution of goods, the classification of freights, or any other valuable information, and to secure these benefits by committees working together for specified objects that will further the interests of the Club as a whole." These objects were largely achieved by the good work of the initial committee, and proper relations were established, so that for a time the Club was essentially of a combined business-social nature, meeting twice a year at Hot Springs and listening to addresses but doing little formal business.

In November, 1911, the requirement of interest representation was eliminated, the name of the Club was changed from Electrical Manufacturers' Club to "The" Electrical Manufacturers' Club, and the object of the organization, as stated in the constitution, was "to gather and disseminate information relating to the broader economic aspects of industry in the United States." Membership was based on the holding of an executive position in an electrical manufacturing company of recognized standing and on this basis the Club now has a membership of 120. The practice of meeting semi-annually at Hot Springs is still continued, and there are no intermediate meetings. Matters of general interest to the industry are considered, but chiefly by committees. Of the new organization the first President was B. M. Downs, elected November 4, 1911. He was succeeded by S. O. Richardson, Jr., serving until November 4, 1914. Walter Cary then became President, succeeded on November 3, 1915, by A. W. Berresford, L. A. Osborne, November 4, 1917, and H. B. Crouse, November 11, 1918. Walter Cary was Secretary 1911-1913; S. O. Richardson, 3d, 1913-1914; A. D. Page, 1914-1915; H. B. Crouse, since 1915-1917, and Shiras Morris since that date.

Electrical Supply Jobbers' Association

The Electrical Supply Jobbers' Association is the successor of a number of organi-

zations that disbanded and reorganized, beginning about 1897. The present organization dates from December, 1908. Its work has been along the line of co-operative effort, such as attempting to accomplish standard forms of packing, and standardization of forms and style, and it has to a considerable degree succeeded in establishing uniformity of procedure. The Association has never had an officer known as President. The General Secretary acts as chairman of the general meetings. The headquarters of the Association from the start have been and now are at 411 South Clinton Street, Chicago, and Franklin Overbaugh has been its General Secretary from its organization.

The Association is divided into three divisions as follows: Atlantic Division—taking in the Atlantic Seaboard and adjoining States; Central Division—taking in the Middle West States; and Pacific Division—taking in the Pacific Coast States. Each division looks after local affairs only.

GEORGE F. MORRISON
Vice-President
General Electric Company

CHAPTER VIII

THE ELECTRIC STORAGE BATTERY

An Auxiliary of Great Value and Economy

THE electric storage battery, or accumulator, is one of the most valuable of all electrical devices. While it is not, as many people think, an original source of electric current nor even a containing reservoir for electric current as such, yet it performs functions of the utmost economy and efficiency exactly similar in effect to those produced through the operation of a dynamo as a generator of electricity. Probably the widest present use for the storage battery is as an auxiliary in electric light and power stations to supply electric current at times when the load is equal to or beyond the capacity of the generating plant. In such cases the storage battery equipment is charged from the station generators at a period when the load on the station is at its lowest point, as, for instance, between midnight and six o'clock in the morning. In its turn, then, the storage battery supplies whatever excess current is required beyond the capacity of the generators during the period of the station's heaviest load, as, for example, between six o'clock in the evening and midnight. Thus it will be seen that the use of a storage battery saves the cost of installing steam engines, boilers and dynamos of a capacity necessary to furnish current for the very greatest load the station is ever called upon to carry. By a simple calculation the average load which probably will be thrown on the station is determined and generating machinery slightly beyond that requirement is provided. Then for the excess over the average or normal load a set of storage batteries is installed. The economy in plant equipment thus achieved is apparent.

All electric train lighting systems are operated on this principle. The dynamo which is attached to the car axle can supply current only when the train is in motion and at a speed sufficiently high to enable it to generate current. When the speed of the train falls below this limit, or when the train stops, automatic switches operate and throw into service a set of storage batteries carried in the baggage car. These batteries previously have been charged by the dynamo while the train has been running at high speed during a period when the demand for current has been small. The same holds true for electric lighting systems on some types of gasoline automobiles.

Another very important and constantly growing use for the storage battery is in driving electric automobiles. The batteries are charged in the garage at night or whenever the automobiles are not in use. In railroad signalling, telephone and telegraph offices, on submarines during their time of submersion and in many other places where it is impossible or unnecessary to operate dynamos the storage battery finds a welcome. Improvements made during the last few years have given the device a stability and reliability which it lacked in the early days.

As Dr. Edwin J. Houston so clearly has explained, "a storage battery cannot any more properly be said to store electricity than a music box can be said to store sound when mechanical power is applied to wind its driving spring. What the storage

battery actually stores is the energy of the charging current. It acts as a device whereby energy is stored up by effecting chemical decomposition, such energy being transformed from mechanical energy to chemical potential energy. In discharging the storage battery this chemical potential energy becomes liberated and appears as electric energy, just as it does in the voltaic cell." Chemical reactions always occur when an electric current is passed through any non-metallic liquid which possesses electrical conductivity. This reaction is called electrolysis and the conducting liquid is known as an electrolyte. In order to get the electric current to pass through the liquid two carbon or metallic conductors are immersed in it. These are called poles or electrodes, the one connected to the positive pole of the dynamo being called the anode and that one connected to the negative pole of the dynamo being known as the cathode. The course of the current flow is from the positive pole of the dynamo to the anode, which it leaves to pass through the liquid, thence from the liquid to the cathode and back along the conductor to the negative pole of the dynamo. All chemical reactions take place at one or the other, or both, of these electrodes and at no other place in the liquid, or electrolyte.

R. L. G. Planté, a Frenchman, is credited with having invented the storage battery in 1859. He used plates of lead immersed in dilute sulphuric acid. Electrolysis was caused by the passage of an electric current through the acid and, by the process known as "forming the plates," the lead plates are changed, one of them becoming finally coated with lead peroxide and the other with metallic lead in a finely divided spongy state. The plates are "formed" by sending an electric current through the battery for a considerable length of time in one direction and then passing it through again in the opposite direction, the operation of changing the direction being repeated many times. After the plates have been formed, if the charging current be stopped, the storage battery will act as an independent source of electricity and will produce an electric current which will flow in the opposite direction to that of the current which was required to charge it. While discharging, the lead peroxide on one plate gives up one of its atoms of oxygen and oxidizes the metallic lead on the other plate. When such oxidization is complete both plates are found to be covered with lead monoxide and the storage battery ceases to supply electric current. If the charging current is again sent through the battery, an atom of oxygen is again transferred from one plate to the other leaving the first plate, as before, covered with a spongy coating of metallic lead and the other with lead peroxide. This process may be repeated during the chemical life of the lead plates or until the plates are destroyed in some other way. Planté's storage battery could retain its charge for a long time, was almost entirely free from polarization and possessed high electromotive force, low resistance and large capacity. Yet it had three inherent defects. Too much time was required to form the plates, the spongy masses of metallic lead fell off the plate after a time for lack of proper support, and the strips of caoutchouc used to separate the plates were short-lived.

Another Frenchman, C. A. Faure, in 1881, made a great improvement by decreasing the time required to form the plates. He did this by giving the lead plates, before they were placed in the battery, a coating of red lead. Thus he shortened greatly the hitherto slow process of the acid eating into the metallic lead. At the first operation of charging the red lead on the positive plate was reduced to lead peroxide and that on the negative plate was changed to spongy metallic lead. In this manner one continuous operation for a period of about sixty hours formed the plates as well as had been done by the process of many reversals of the charging current. With the proper rest at intervals Faure made batteries which lasted as long as three months. He also employed felt as a separator between the plates. The difficulties encountered in keeping the spongy mass of metallic lead and the peroxide attached to their respective plates caused a number of inventors to investigate the problem. Among these were Volckmar, Swan, Sellon, Brush and others. The result of their experiments was that the lead plate was abandoned for a lead grid, which is a lead support in the shape of a trellis, with holes of various sizes into

which the red lead in the form of paste was forced. The necessity for the use of felt was thus obviated and proper mechanical support was provided for the spongy mass of lead. It was found, however, that this did not work so well with the positive plate as the contact of the peroxide with the metallic lead of the grid, in combination with the acid solution of the battery, started a local action which eventually destroyed the grid. Many makers of this type of battery were able, notwithstanding this defect, to so construct their plates as to defer this disintegration for a long time. A number of inventors, including Tribe and Fitzgerald, endeavored to do away with the supporting grid for the positive plate, but their batteries côuld not compete commercially with the older type.

There was great rivalry for many years between the Planté type of battery and the Faure, or "pasted," type, which has resulted, in modern practice, in the use of a mixed type which combines the merits of both. There are on the market today a considerable number of storage batteries commercially and scientifically satisfactory. The prime requisites for a successful battery have been proved by experience to be the choice of absolutely pure materials and scrupulous care in all manufacturing processes. In practice it has been demonstrated that the water used in the batteries to replace that lost by evaporation must be pure and, therefore, distilled water is generally used.

A great, and very much to be desired, saving in the weight of the storage battery could be secured by the use of any other metal than lead in its construction. But other metals do not possess the ability to resist the action of the acid electrolyte as does lead. Many inventors and experimenters have endeavored to use an alkaline liquid as an electrolyte, but not with complete commercial success. Among these innovations are the batteries of Lalande-Chaperon, Desmazures and Waddell-Entz.

The most successful non-lead storage battery is that invented about 1903 by Edison and since improved and developed commercially to a large extent. It is especially well adapted by its small size and comparatively light weight for use on electric vehicles and in this direction has found a wide field of application. The plates are made of very thin sheets of steel nickel-plated. In each of these 24 rectangular holes are stamped, leaving the plate in the form of a metal framework. Pockets of perforated nickel-steel were fitted into the holes and pressed into permanent position. The active material is then placed in these pockets. For the positive plate the active material is nickel peroxide mixed with flake graphite, while that for the negative plate is finely divided iron mixed with graphite. Special processes are used to prepare both kinds of active material and the function of the graphite is to give increased conductivity. For the electrolyte a twenty per cent solution of caustic potash is employed. During the period of discharge the iron is oxidized and the nickel is reduced to a lower state of oxidation. During the period of charge the reverse action occurs.

Early tests on the Edison battery showed that it had an electromotive force of 1.33 volts which grew slightly greater after the charge. The battery can be charged and discharged at any rate and, up to a certain point, is said to be improved by use. In one hour's time the cell could be fully charged and it would stand up under a discharge rate of 200 amperes. A battery weighing about twelve and one-half pounds gave 14.6 watt-hours per pound of battery at a twenty ampere rate and 13.5 watt-hours per pound at a sixty ampere rate. A lowering of capacity of the battery was discovered to be caused by gas pressure enlarging the pockets of the positive plate. This was corrected by altering the form of the pockets and substituting for the graphite a metallic conductor in the form of flakes.

The manufacturers of the lead battery have not endeavored appreciably to lessen the weight of their cells which are designed for stationary service in electric lighting and power plants. Also, for such purposes, practice has disclosed that long life and reliability are more important than a specific output per pound of battery.

The use of the lead battery for operating electric railway cars has, in spite of many attempts, never been commercially successful. The size and weight of the cells required to deliver the necessary power to drive the car has precluded any possibility of efficient and economical op-

eration. For electric automobiles special types of lead battery have been designed which are commercially successful. Certain of these have operated cars for a total of over 3,000 miles before wearing out. The matters of vibration, weight and limited space have been the controlling factors in designing cells for this purpose. Generally the plates are thinner and placed closer together, the acid in the electrolyte is stronger in order to produce a higher voltage and ebonite or wood separators are placed between the plates to prevent the active material from being shaken out of the grids. The necessary requirements for heavy vehicles are about fifty watt-hours per 1,000 pounds of vehicle per mile.

Ignition batteries for use on gasoline automobiles, although of smaller capacity, are built along the same lines as cells for traction purposes. Generally two cells are placed in an ebonite container and connected in series so as to give a four volt battery, which is the standard to which sparking coils are usually designed. From twenty to one hundred ampere-hours is the usual capacity range.

CHAPTER IX

ELECTRICAL SECURITIES AS INVESTMENTS

ONE of the greatest financial authorities in this country, Mr. Frank A. Vanderlip, declared in a speech made before the National Electric Light Association five years ago, that "four hundred millions a year, eight millions a week, of fresh capital can profitably be used in the development of the whole broad field of the electrical industry in the United States during the next five years." The event has exceeded the estimate, because of the abnormal conditions that have been precipitated upon the country. But even before war conditions intervened, it has been written large in the electrical statistics of the last quarter century that the progress of electrical industry has been at a pace that outruns the predictions of the most rosy optimists.

The story of electrical progress has many aspects. From the scientific side there is the story of patient research of many seekers after the physical verities, wresting Nature's secrets from her bosom and discovering the facts and some of the phenomena connected with a kind of energy previously unrecognized. On the side of the engineer there are the mechanical and chemical means by which these phenomena are marshalled in obedient order, and the mathematical means by which their force, current, capacity and other measurable characteristics are calculated. There is a manufacturing side in which the machinery and apparatus required for the production and use of the electrical current are made; a service or public utility side through which the current is generated, and then distributed by wires and cables, and a commercial side, auxiliary to the manufacturing and public utility activities; selling their products and providing them means of support and continuance.

But intimately associated with all these activities, and essential to their initiation, is the matter of finance. In the creation of any electrical enterprise there is a question of initial expense which, if the enterprise is to be conducted upon any important scale, must be correspondingly large. For the creation of this initial fund capital must be raised as in any other large business enterprise. It is, therefore, a matter of large importance in connection with the future of the industry to know something about the standing and prospects of returns from electrical enterprises as compared with other investments in industrial securities.

From the investment standpoint the electrical industries consist of two classes, one composed of electric railway, light and power, telegraph and telephone companies, which belong to the public utility group, and the other of the manufacturing companies producing the machinery and apparatus for these electrical applications. The latter belong to the industrial group and, speaking broadly, are governed as to financial computation and appraisal by exactly the same general rules as apply to other industrial enterprises requiring capital for their flotation and creation.

In the public utility group the companies need large capital to create their plant and facilities, and when in running order not only have to meet the demands of their customers and at the same time endeavor to make satisfactory returns to their investors, but they also have to submit to certain measures of governmental supervision and control, exercised through commissions or some other media, with power

over rates and other matters which, primarily intended to see that the public gets efficient service at a reasonable rate, has also a reflex action in the limitation of the maximum return the investor in the company may obtain on his investment. There are, on the other hand, certain tangible compensations to the investor in connection with this governmental supervision, which will be referred to later in this chapter.

The investor in stocks, bonds and other securities does so facing considerations of the safety of the investment and the certainty and amount of the return. In deciding upon the making of investments in any class of industrial or public utility corporations, it is important to know not only the record of the individual corporation, if it is already a going concern, but also the general condition of the industry it represents and its prospects for the future, these being especially important considerations for one who is investing in a new company.

There has been in the last twenty-five years an expansion of public utilities and an increase in public utility investments that is one of the most remarkable developments of the age. This is true of all classes of public utilities, even those of old-established classes, such as gas and waterworks, which have responded to the tendency of rural populations to flock to the cities, and the consequently increased needs for public service of this kind which comes with urban growth. But electrical utilities such as street, subway and elevated railways using electric propulsion, electric light and power plants and telephone systems have multiplied in number and increased in size at a rate out of all proportion to the rapid increase of the population of cities. The city systems of these utilities have reached undreamed-of growth and though, for instance, the fifty largest cities of this country in 1910, with a population of 20,402,138, had grown from a population for the same cities in 1900 of 15,238,935, or 33.2 per cent, in a decade as shown by the United States census, the commercial and municipal central electric light stations from 1902 to 1912 showed for that decade the remarkable increases of 252.5 per cent in income, 161.6 per cent in persons employed, 308 per cent in developed horsepower, 323.6 per cent in kilowatt capacity of dynamos, 360 per cent in output of station kilowatt hours; 31 per cent in arc lamps and 320.5 per cent in incandescent lamps wired for service, and an increase of 330.9 per cent in number and 843.1 per cent in horsepower of stationary motors served.

These wonderful comparative figures indicated not only an undreamed-of growth of electric central station service in the cities and their immediate suburbs, but also a reaching out into rural places for which such facilities were regarded as utterly unattainable a decade or so ago.

Until recent years public utilities, so called, were regarded as strictly urban phenomena, but at the present time the characteristics of urban life are developing into those of life throughout the country. The extension to country places of the telephone, the trolley-line, the electric light and running water have an urbanizing effect on rural regions which makes the life of the villager and small city resident one of comfort and ease compared to that of his forebears down to those of the last preceding generation. Even the farmer, within a few miles of a village, with telephone connection and central station service or an isolated electric plant is advantaged in the same modern way, and with an automobile added is socially as near to the center of things as the city resident. In fact no small part of the revolution brought about by applied electricity is the spreading of the economic and social advantages of city life over the rural districts.

This expansion of telephone, electric light and trolley-line to the country is also an enlargement of the area and increase of volume of investment. Indeed, the investment in such lines is usually greater in proportion to population served than is required for strictly urban service.

It was just about a year after the last census of electrical development was taken, that for the year 1912 (that for the five-year period 1912-1917 is not yet available) that Mr. Vanderlip estimated that the progress of electricity for the next five years would call for a new investment of "four hundred millions a year, eight millions a week." But the ratio is greater than that and the expansion is still going on, for, great as the growth has been, a recent

estimate puts the proportion of our American people who are enjoying the benefits of electrical service at 30 per cent. So that there is a field of potential additions to electric utility service of 233 per cent even if the population remains stationary and the amount of service per capita of those served does not increase. But neither of these two things is likely to be. The population of the United States will continue to grow, and the introduction of public utilities habituates the people to higher standards of living, the luxuries of today becoming the necessities of tomorrow.

To record the growth of the volume of business of electric service utilities is sufficient to show that intrinsically they are excellent media of profitable investment. Conservatively capitalized, properly managed in its operating and commercial departments a central station company in any fairly populous community may look forward to a constant growth in business. The same is true of the other utilities which, from their nature, must be largely monopolistic. Two telephone systems in a city are a nuisance, and a telephone, to a large number of users, is of value to them in proportion to the extent and volume of its local and long distance connections.

In the early days of the telephone the shares of Bell Telephone stock went begging. A few people had faith enough in the future of the device, which others were designating as "an interesting but impractical scientific toy," not only to invest in the stock and hold on to it. Theodore N. Vail, now at the head of the telephone business, is said to have made one purchase of stock for $2,400 for which he was ultimately offered two million dollars. However, for the first ten years of the Bell Telephone capital was inclined to look askance at it. But for thirty years it has had no difficulty. Its stock is at a premium and its regular dividends return 8 per cent on common stock of the American Telephone and Telegraph Company.

In the early days of both telephone and telegraph there was much that was speculative in company stocks. Rival systems established companies operating in limited areas. Many companies were organized in different states that never built a line. Speculators bought companies, wrecked them and bought them in again through receiverships and reorganizations by which stockholders and creditors were cheated.

But Government or State regulation, whatever criticisms may be made of it, has been a stabilizing force, and today the shares of the principal telephone and telegraph organizations are regarded as "gilt-edged," with extensions always being made in their systems, profits assured, and dividends regularly paid. Governmental supervision as it becomes settled gives greater heed to the equities of the various parties, the Company, the stockholders and the public. Speculative possibilities are reduced, but profits on a conservatively liberal basis are assured at a rate considerably better than can be obtained on a real estate mortgage and with safety of the investment no less assured. There is scarcely another class of securities the returns of which carry such permanency and favorable percentage.

First of all, the electric service company, especially if it serves a well-populated area, is doing an increasing business. A building or industrial plant which has once adopted electricity rarely discards it, so that every new connection means a new customer, and a new customer means a permanent addition to income with a smaller comparative augmentation of service cost so long as the total remains within the generative capacity of the existing plant.

One of the most important items in the computation of the earning power of a corporation is that of labor cost. Wages have been increasing and the demands of labor steadily rise with the cost of living. Therefore the relation of wage cost to total operating expense and to gross earnings has an important bearing upon the return to be expected from the investment. In railroad operation wages approximate 35 per cent of gross earnings and 50 per cent of the total operating expense, and a recent writer has shown that a wage increase of 10 per cent to railway workers would seriously endanger interest payments. But in electric light and power companies wages represent about half as much, proportionate to gross earnings and operating expenses, as is the case with both electric and steam railroads. Another advantage is that the employes of electric companies are, for the greater part, of the

higher grade and the industry is practically free from strike danger. Electric service properties are generally less subject than other utility investments to the difficulties which deter the judicious investor, such as dangers of municipal interference, depreciation hazards and fluctuating cost of raw materials.

The securities of the large electric service corporations, because of the economies which they are able to introduce, are especially attractive as investments for trust funds, savings banks and other investors of the more conservative classes. This is especially true with reference to the operating economy effected by the concentration of central stations which entails only a single management but admits of many fields. About three years ago the London County Council (which is an exemplar of a municipal service corporation of the highest type) abandoned an investment of £8,000,000 because it represented a multiplicity of inadequate stations. Because of the great technical operating advantages of large electric light and power companies, their securities are highly favored as investments by many discerning capitalists of strongly conservative tendencies.

The trend of the electric light and power service corporations is toward union of contiguous operative areas under one management. This is strongly shown in the report of the census of commercial and municipal central electric stations in 1912 as compared with that in 1902. In the older report the 3,620 "stations" listed were the actual stations without reference to their management; but in 1912 the station unit was that of operative management, and two or more stations under identical direction were listed as a single station. Therefore while the number of "stations" listed in 1912 was only 5,221, an apparent increase of only 44.2 per cent, the output in kilowatt hours increased 360 per cent, the kilowatt capacity 323.6 per cent and the income 252.5 per cent.

Many of the advantages which inhere in the large electric corporation are carried to the electric service companies of the smaller cities as the result of the work of banking-engineering firms and organizations devoting their energies to buying, financing, improving and operating public utilities. By specializing along these lines, with all the advantages in buying and selecting machinery, apparatus and supplies that the largest city companies enjoy, by the maintenance of engineering organizations which carry on the technical part of construction, operation and maintenance with all the advantage that experience and ability can command, these large firms have carried the benefits of electric service of the highest efficiency to many of the smaller cities and towns of the country. The work is done largely by the organization of local corporations closely allied to the general "holding," managing and operating firm or corporation. There is an increasing tendency to encourage the investment of local capital in these local service corporations, thereby increasing "home interest." All utility corporations engaged in public service have a vital interest in the growth of the region which they serve. If a town grows rapidly rails are laid, pipes extended or wires strung in that direction. If population decreases in one direction fewer cars are run and less service is required in that direction. But in the shifting of population from one part of a city to another part the electric service corporations have an advantage over other utility enterprises in that it is much more expensive to take up rails or pipes than it is to transfer wires. And the telephone and other electric service corporation has the advantage that a large portion of its property can be economically shifted to meet varying public needs within the given area.

While many of the reasons and grounds for investment in electric service corporations engaged in providing light and power apply with equal force to electric railroads, there are some points of difference. The railroad is *per se* a monopoly of public service in the territory it serves. In certain cases the electric railway may be in competition with a rival line which parallels it too closely, but in cities at least the modern policy places the entire surface railway franchise for the city or at least some large portion of it in the hands of a single company, and in that case usually makes transfer privileges a condition of the charter. The urban and suburban electric railway systems have a great advantage over other utility corporations in that they are largely the creators of their

own prosperity. A new electric line, giving rapid transit from a city center to some section of a city or nearly suburb which has previously been without such facilities, immediately increases the residential value of the places to which it introduces the benefits of rapid transit. Such rail extensions give to regions served an increased share of the economic advantages of city life and lessen or remove the handicaps under which a region badly served for transportation must be. Delos F. Wilcox, in a recent paper read before the American Academy of Political and Social Science, said:

"It is readily observed that the larger an urban community becomes, the more dependent are its inhabitants upon public utility services. Furthermore, in the case of the leading utility, transportation, along with this necessary dependence goes the necessity of a larger *quantity* of service per capita. This is well illustrated in the development of urban transit in New York. Over a period of fifty years the number of street railway fares annually paid per capita increased from 43 in 1860 to 321 in 1910. Even after the electric trolley system had been fully developed, the increase for the decade from 1900 to 1910 was 75 rides per capita, or more than 30 per cent. Moreover, in a rapidly growing community, public utility investments tend to lag behind the demand for them, and, therefore, even if a city's growth slackens or stops entirely, the demand for public utility expansion continues until the community has spread itself out, provided itself with all the necessary conveniences of modern life and settled down into a static condition. Just as long as the population of a city continues to press out into outlying districts, or to shift from one district to another, even though there may be no actual increase in the aggregate number of people or the quality of utility service required, new investments will be necessary, since existing investments in pipes, wires, tracks and other street fixtures cannot readily be moved from one place to another to follow the shifting population."

The electric railway, and especially the trolley system, has had a vast influence upon the rapid growth in the country's material welfare. The comparatively small cost of construction of a trolley road as compared with any other has made it possible to connect town with town and village with village by rapid transit, in a way that has revolutionized the organization of social and industrial life. Interurban relations have been made more intimate. Manufacturing enterprises in small cities furnish employment to labor not only within their own urban lines but also to surrounding villages accessible by trolley lines. The "slums" of large cities are largely losing or at least diminishing their worst features of congestion, those that remain being largely peopled by unassimilated immigrant populations whose descendants are becoming Americanized. Accessibility of labor to the factory, which formerly implied congestion of population to an unsanitary degree, is greatly increasing, while many industries are, because of the application of electricity to industry, made possible near the source of their raw material instead of being located in great cities where such materials, as well as the coal for the supply of heat and steam, had to be brought to the big city in order to find the labor necessary to keep the wheels of industry moving. Not only are the electrical industries promotive of the supply of labor and the comfort of the laborer by the vast improvement in transportation, but in themselves they are the most valuable contributions to industry that modern progress has brought. Besides the armies of laboring people and mechanics who are directly employed by the electric railway, light, power, telephone and telegraph companies, and the manufacture of electrical machinery, apparatus, and accessories of every kind, electrical science has created industries in manifold ways. By the concentration of intense heat only made commercially possible by the invention of the electric furnace, the manufacture of carborundum, of aluminum, calcium carbide and many other materials of great value have been made commercially possible. By it the adequate use of water power has been accomplished, and by conversion into electric energy the power of the cataract is distributed, with little loss in transmission, to great distances. Mines which were not worth working by old methods and processes have been made valuable. Coalmining has been revolutionized through its adoption of electric light and power. The

automobile has been greatly benefited by the applications of electricity that have been made to it not only for propulsion but also for lighting, starting, etc., on cars using other motive power. All of these applications mean not only new avenues of opportunity for labor, but also new openings for capital.

Electrical manufacturing companies have been developed along lines that have brought to them growth and present prominence found in few other lines of industry. There are still various companies confining their attention exclusively to some small department of the electrical industry and in some cases making much success in their special lines, but in the light of general investment media the thought of the average investor as to electrical manufacturing concerns naturally reverts to those large companies which cover complete lines of equipment for electrical railway, light, heat, power and industrial plants.

Founded in the first place upon the ownership of basic patents for various electrical machines and apparatus these great companies have been continually expanding their operations and organization until they have a business that is world embracing in scope and are the leading enterprises of their kind in existence. The progress in the electric field has been in very large measure their work, which has been in the very broadest sense educational as well as industrial. Many of the greatest of our electrical engineers received much of their training in the testing rooms and other departments of these companies. In creating, by the supply of improved machines and the invention of new applications of electricity, the bases for many service companies, these manufacturing corporations have themselves reached a most enviable position in the favor of the investing public. Thus if we scan the financial market reports from week to week we find the stock of these corporations continuously quoted at a substantial premium and their other securities at par or better.

Strongly organized, completely equipped and ably managed, the securities of these companies have long been on a conservative investment basis, with dividends regular and no tendency toward any sensational fluctuation. Unlike the service companies they are not under any governmental regulation that does not apply to other industrial investment, but they have all the qualities of the best of them, having in addition to present sound financial basis, complete facilities and excellent management the further quality, not applicable to many other industrials in equal degree, that they are manufacturing lines of machines and apparatus which are and must continue to be for many years in constantly expanding demand; that with their excellent laboratory advantages and their technical staff of scientists and engineers they are constantly adding new and valuable features to the resources of electrical science and are, in short, producers of articles for which the demand keeps up with capacity and which increases with the number of people and places that adopt for themselves the advantages of applied electricity.

Speaker Thomas B. Reed used to describe himself as a man who was always a "bull" on American progress. So far as that progress is expressed in material physical improvement it is synonymous with increasing electrical equipment. In this electric age when inventive genius, scientific research and productive industry are so largely centered on electrical objects, it is timely for money and capital to be focussed in the same direction. It is already largely so, and while there may be greater ephemeral gains in other fields for the clever speculator who knows how to get out as well as how to get in, it would be difficult to find an arena which better represents to the investor safety, steadiness and substantial profit combined to a more complete degree than the electrical field.

By the census of manufactures of 1914 it was shown that the total value of the manufactures of electrical machinery, apparatus and supplies for the calendar year 1914 aggregated $359,432,155, as against $240,034,155 in 1909, and $159,551,402 in 1904 and $105,831,863 in 1899. The year 1914 happened to be a year, too, in which there was less than normal activity in most industrial lines, partly because of uncertainty of legislation in the early part of the year and partly because the last five months were those of the beginning of the world war. Yet without regard to this temporary slacking of industry in that year the output showed an increase of 49.74 per

cent in five years, 125.28 per cent in ten years and 239.63 per cent in fifteen years in the value of the product for twelve months. With the speeding up of electrical industries which has come with the great increase of electrical equipment in factories of all kinds in the past three years there is no question that the increase of the electrical machinery and apparatus industry has been at a pace considerably above any antecedent normal.

During the five-year period 1909-1914 the most rapidly increasing item in the manufacture of electrical apparatus was in the production of devices connected with automobile and motor car equipment and propulsion. During the three years and a half of the world war to this present time the manufacture of electrical apparatus in connection with military and naval requirements has been, of course, a most prominent feature.

It is only in recent years that water power has become an important element in the electrical industry. Conservation of water resources has, during the past ten or twelve years, become an important economic problem, largely looked upon as one in which the Federal or State governments were the principal parties in interest, or, in the case of Niagara, one in which international arrangements were important. But, although this is true from the legal aspect, it is in a still more vital degree an urban problem.

There are not many great water powers where, as at Niagara, important urban populations are near at hand and the water power problem is largely one of how to bring to people in urban communities the resources which Nature has stored in the wilderness. Vast powers reside in the water resources toward the head-waters of our river systems, which are either unused or only very inadequately used at the water's edge. Great progress in industry waits on the completion of transmission enterprises which shall convert these powers (many of them without impairing their value for irrigation and other purposes), into electrical energy to be transmitted to manufacturing centers as motive power for the wheels of industry. Here, as at Niagara is opportunity for the profitable investment of capital in enterprises of continuous earning power which shall at the same time spread over wider and wider areas as the advantages of applied electricity become more generally appreciated. For several years past there have been few additions to the developed water powers, not because there is not need and demand for them, but because Government restrictions made them unattractive to capital. A more liberal policy, which contemplates a fifty-year lease and a great liberalization of conditions, is now being adopted and doubtless there will be a large development of hydro-electric operations which will give profitable returns on the investments made in them. While the original cost is heavy, the well-placed hydro-electric plant generates current at a much lower operating cost than is possible to a steam-driven plant. The rule is almost universal that such enterprises, while paying small dividends during the initial years, soon reach a much higher level of dividend distribution.

Electrical utility securities for a number of years following the panic year of 1907 showed a general and quite remarkable increase in both gross and net earnings, quarterly dividends of 2 and 2½ per cent becoming the rule among the stronger companies, while a strong annual increase in the demand for electric service caused constant activity in new construction. In many cases the dividends would have been larger except for the restraint put upon them by public service commissions. Their great stability made the stocks and bonds of electric light and power companies a favored investment for conservative people. But in 1917 the list of electric utility stocks and securities showed a considerable decline in prices. It was not because of a decline in the use of these public utilities, for, as a fact, the activities of the companies showed a greater growth than ever. The demand for additional power on the average central station in industrial communities outran the ability of the station to supply. Great as the annual increase in gross earnings has been for several years, it was far larger in 1917 than in any previous year. At the same time the operating expenses and every commodity cost entering into the operation or betterment of public utilities increased in much higher ratio, and wages were increased to meet the higher cost of

living. As a consequence the net earnings declined, out of which the interest and dividends must be paid. This was true not only of electrical but also of every other public utility.

The only way to get near to normal net income was to secure increase of rates, but in almost every case some commission or board has to be consulted about that, and these are usually very hard to convince. In some sections increased rates were obtained, but in others there has been much delay in securing permission to raise rates, while supplies needed by the electric companies increased, as compared with the prices of 1915: copper wire 180 per cent, copper 150 per cent, brass goods 300 per cent, tool steel 400 per cent. Cast iron pipe and forgings doubled, car axles and die-plates trebled, and coal was often almost impossible to get, even at more than three times its ordinary price. These facts are such strong evidence of the justness of the contention of the utility companies for the right to increase their rates, and that right is being allowed in an increasing number of cases.

Mr. W. B. Jackson, of the Bond Department of H. L. Doherty & Co., in a recent article on the Utility Securities Market, calling attention to these conditions in connection with the ever more insistent demand of manufacturers for power to an extent far greater than within the ability of the companies to supply under present conditions of material and labor, says:

"What this means to the holder of central station securities may easily be seen. The investor, buying these securities at their present prices, has only to wait a few years to be astonished at the enhancement he will see in their market and intrinsic value and in their earning power."

The securities of electrical manufacturing companies have a history of the most wonderful development. Their record of expansion and dividend paying is equal to that of the most prosperous of the great enterprises of the country. The early and persevering investor in the great electrical industries, such as the General Electric, Western Electric, Bell Telephone, and the electric light companies in the larger cities, has realized most substantial returns.

The reason is that he has invested in an industry that is still growing all the time, with greater growth to follow until all the world is electrically equipped.

A Partial View of the General Electric Company's Plant at Fort Wayne, Ind.

JAMES MITCHELL

JAMES MITCHELL

The latest among many interesting chapters in the life of James Mitchell concerns what he calls his "principal" occupation, namely, directing the destinies of the Alabama Power Company with its 200,000 H.P. installed generating capacity, and one thousand and odd miles of transmission line. Such an important addition to the hydro-electric resources of the South brings the stimulation of industry that is so vital a condition to future progress and reflects a corresponding measure of credit upon the organizer and developer. Under his supervision the company has applied a part of its power to the manufacturing of high grade steels by the use of electric furnaces which have also been the medium for extending the production of ferro-manganese, which has developed into one of the largest plants ever constructed for the purpose, at Anniston, Alabama. During the war this plant satisfactorily treated low grade domestic manganese, thereby releasing badly needed shipping space, which would otherwise have been used to bring ores from abroad. James Mitchell is a man of many parts, known in both the North and South American continents, associated with the leading personalities and movements in early telephony and the introduction of electric street railways, a much traveled and indefatigable engineer, inventor and industrial promoter. Born in Ontario Province, June 18, 1866, he prepared for Harvard University in the Milton High School, at Milton, Mass., graduating in 1882; but his ensuing education was gained in other than academic halls, and doubtless more to the edification of the young novice, for he fell heir to several unique experiences in consequence. The perspicacity of the head master at Milton, as if he were a special instrument of Providence, influenced him to plunge at once into the workaday world of science as the best incentive to his marked scientific talents, which he did, entering the employ of Stearns & George (later Charles L. Bly), 37 Pearl Street, Boston, who were manufacturing electricians and instrument makers when the art, as the saying goes, was still in its infancy. He met and assisted the inventor, Milliken, prominent at the time as a telegraphist, manager and inventor and a keen rival of Bell in the controversy waged over the question of whether telephone speech was effected by a wave of varying current strength or whether the telephone transmitter functioned by reason of an absolute make and break in the current. Milliken acknowledged the breakdown of his theory after he had disproved it by cutting into the circuit a Wheatstone Telegraph transmitter, running at high speed. A chemically treated tape, recording the operation of the transmitter, showed unmistakably a current of varying wave strength as patented by Bell. The experimental work of Milliken produced numerous types of transmitters and receivers, some of the instruments giving great satisfaction and being superior to standard telephone equipment of a much later period. On one occasion, in 1883, the two sat, each in an adjoining room of the Western Union Telegraph's Boston offices, and conversed via New York over two telegraph lines connected at the New York end. Another of Mitchell's youthful performances was the superintending of arc lamp installations at expositions. It was his duty, among other things, to see that the carbons fed properly, which often necessitated climbing to the trusses of the buildings, where a black thread was run to the carbon rods of the lamps to assist their erratic operation. The next turn of fortune's wheel put him on the road to permanent prestige and power in the fresh field of electric street railway building. At that date the idea had just begun to spread and a colossal amount of construction awaited the electrical engineer. The Thomson-Houston Company were carrying out extensive operations of this sort, so it was an auspicious start that Mr. Mitchell made in 1884 at the Lynn, Mass., plant of that company. The making of instruments, models, and experimental apparatus, much of the time under the direct supervision of Professors Thomson and Rice, kept him busy, as did the actual making of all the volt and ampere meters turned out at that early day in the Lynn plant. Later, when promoted from instrument maker and toolmaker to

be a foreman of the so-called Special Department of the Thomson-Houston Company, he had charge of their first manufactured stationary and railway motors. Their railway department then claimed his services, and in 1887 he went to Allegheny City on a mission of coöperation with the Bentley-Knight group in the installation and operation of the Observatory Hill Street Railay. Bentley and Knight will ever be remembered as among the most active of pioneer electric street railway builders. The difficulties encounterd may be illustrated by the circumstances surrounding the adoption of the carbon brush for motors. The prevailing use of copper leaf brushes appeared to be an insuperable cause of trouble, but the proffered remedial suggestion in favor of carbon was thought impracticable, believing that it would offer too high a resistance and badly wear the commutator. While Mitchell was in close association with Charles VanDePoele the problem came up again. That scientist had the clue, replying to the objections with the statement that carbon would not be a high resistance for a 500 volt trolley current, as it would be for the low voltage between commutator segments, and was therefore the material for the ideal brush. Indeed, so it proved to be after Mitchell had fashioned a set of brushes from a slab of carbon purchased at a local supply store. To the amazement of beholders, when they were applied the commutator ran sparkless under every condition. Mr. Mitchell immediately adopted the new discovery in all his work, but received for his pains a severe reprimand from the company, who, fearing possibly an impairment of their reputation, more likely because of the patent situation, sent instructions that henceforth copper brushes should be ordered as usual from the factory. Thereafter they were duly ordered and as duly disposed of to local brass foundries. Finally, the company, through a circular letter, informed all "experts" that, after much experimentation and study, the factory (!) had developed a carbon brush superseding the copper brush and that thereafter orders might be placed for catalogue No. ——— etc. In the months that followed Mr. Mitchell designed and suggested many improvements of street railway equipment. While an engineer at the Chicago office of the Thomson-Houston Company he had charge of the building and equipping of street railway cars and trucks at the Pullman works, and the electrification and operation of numerous street railways in the Middle West. From there he was sent, in 1890, to California as Chief Engineer of the Pacific Coast Department, and later was briefly located at Denver, Colo. Then began the foundation of an intimate acquaintance covering seventeen years with electric utilities in Brazil. He had gone to Rio de Janeiro to install equipment for a special 24 in. gauge mountain line, he remained to supervise the equipment of the Botanical Garden Street Railway, the first electric street railway in the southern hemisphere, and to aid in introducing to Brazilians the conveniences of electric light, the telephone, and other products of electric power. He was associated, at the Brazilian end, with Dr. F. S. Pearson, who was directing the financing and construction of the Sao Paulo Tramway, Light and Power Company and the Rio de Janeiro Tramway, Light and Power Company. The entire street railway, light, power and telephone systems of these two cities are controlled by the two companies merged under the name of the Brazilian Traction Company. Their present hydro-electric developments utilize about 200,000 H.P. and further water powers of enormous potential value are in reserve. For the past ten years Mr. Mitchell has maintained connections with Sperling & Company, London bankers, who helped finance many enterprises in Canada and Latin-America. His New York offices are at 120 Broadway. Besides being president of the Alabama Power Company, he is a director or official in a dozen or more electric power companies, chiefly in the South, and in foreign countries. Mr. Mitchell's tastes in reference to club life are apparent in his membership in the Engineers, Union League, Automobile of America, Columbia Yacht, Downtown Association and Bankers clubs of New York; the Royal Automobile, and Stoke-Pogis Golf clubs of London, England; the Roebuck Country Club, of Birmingham, Alabama; and the Engineering Club of Rio de Janeiro.

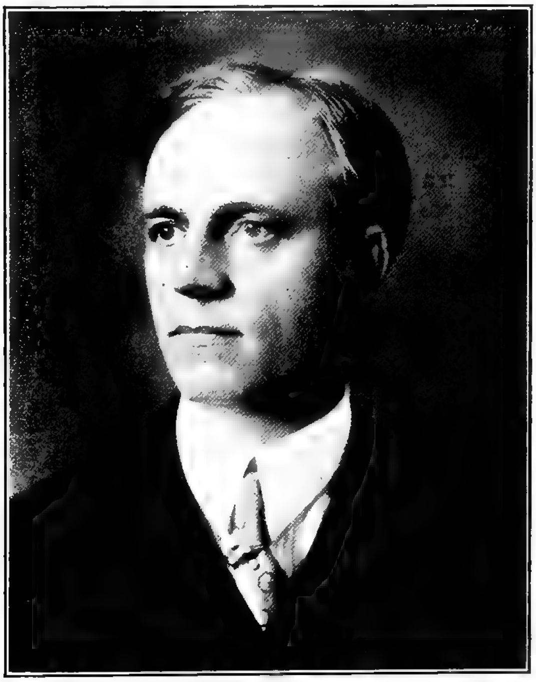
JAMES E. McCLERNON

JAMES E. McCLERNON

James E. McClernon, president of the Northwestern Electric Equipment Company, had wide experience in the manufacture and sale of electrical apparatus before becoming associated with the company of which he is now the executive head. Mr. McClernon, who is of Scotch-Irish descent, was born in Brooklyn, April 21, 1879, the son of James and Margaret (Fields) McClernon, and was educated in the public schools there. From the time his schooldays ended until he was twenty years of age he was associated with commercial lines, and in 1899 he became an employee of the Western Electric Company. He served a regular apprenticeship with this organization, familiarizing himself with every branch of the business from the mechanical end to the sales department. Upon leaving the Western Electric Company in 1910, to accept an official position with the Northwestern Electric Equipment Company, he brought to his new connection a complete knowledge of the conditions and buyers in the territory the Northwestern intended to invade. This company had only been organized four months when Mr. McClernon joined it and it was through his efforts the first business was secured and the organization started on its successful career. At that time the business was located in Brooklyn, where one small floor was sufficient for stock purposes and Mr. McClernon and one stenographer constituted the entire office force. In 1913 the business had so increased that the office was removed to Manhattan and additional warehouse space secured in Brooklyn. In a short time these increased facilities were found inadequate and the building at 35 Vestry Street was leased. The offices were removed to the new location and the Brooklyn warehouse discontinued. It was thought at this period that the seven floors in the new building would suffice for the term of the lease, but the business soon assumed such large proportions that double the floor space is now required and a new building that will fully accommodate the growing trade is being sought. From an office force of one, Mr. McClernon now directs a staff of fifty-five employees, which is a most healthy showing in the eight years the company has been in operation. Mr. McClernon was made vice-president of the corporation one year after he became associated with it, and in 1914 was elevated to the presidency. The Northwestern Electric Equipment Company operates in the territory within a radius of 200 miles of New York City and for this work employs a large and capable sales force. The concern confines its efforts to the wholesale jobbing of electrical merchandise and it was the pioneer house in the line to originate the system of wholesaling only and absolutely refusing to sell any goods at retail. This policy, together with other reforms in sales methods instituted by Mr. McClernon, has made the company most popular with the trade and been of great aid in largely increasing the annual sales. Mr. McClernon is a member of the Engineers Club, Transportation Club, International Millers Club, Crescent Athletic Club of Brooklyn, N. Y., Haworth Country Club of New Jersey, president of the Electrical Club of New York, an organization which includes in its membership the entire electrical jobbing trade of the city, and is treasurer of the Westinghouse Agent Jobbers Association, another strictly trade organization. He resides at 166 Halsey Street, Brooklyn, New York.

DONALD McNICOL.

Donald McNicol, an electrical engineer whose specialty is telegraph engineering, who since his seventeenth year has been actively identified with the practice and progress of the art of telegraphy, was born in Canada, July 23, 1875. He is of Scottish lineage, and one of his ancestors was one of the Scottish chiefs who, when



DONALD McNICOL

Sir Walter Scott was a boy, introduced him to the Highlands of Scotland. Mr. McNicol's family emigrated from Scotland to Canada in 1820, and is still located there on the lands taken up at that time in Lanark County (now in Ontario, but at that time in the Province of Upper Canada).

He was educated in the schools of Canada, and received his engineering and technical education in night schools and in special lecture courses. He early experienced a desire to know and practically learn about electricity in general and telegraphy in particular, and at the age of twelve received a strong inclination in that direction through reading R. M. Ballantyne's "The Battery and the Boiler," giving an account of the laying of the first Atlantic Cable. As soon as possible thereafter he procured employment in a telegraph office. From 1892 to the present time he has been continuously employed in telegraph service—for the first four years in Canada, and since then in the United States. His service for fourteen years was with various railway systems in the West, and since 1906 he has been with the Postal Telegraph-Cable Company, for which he came to New York as assistant electrical engineer in 1909, in which position he continues.

Mr. McNicol has always been a student, deeply interested in the problems of telegraphy, telephony and radio-telegraphy, and for years has been recognized as an authority on those subjects, and a foremost contributor to the professional literature along those lines. He has written more than fifty technical papers which have been published dealing principally with telegraphy, telephony and radio.

In 1908, while located in the State of Utah, he served as secretary and as member of the Executive Committee of the Utah Society of Engineers, and in the same year was appointed by Dr. J. F. Merrill, director of the State University of Utah, as a special lecturer in electrical subjects in the Utah State University at Salt Lake City. Since coming to New York he has served as instructor in The Technology of Telegraphy and Telephony, 1911-1912, in the evening technical schools of Columbia University; and in 1915 he gave a course of lectures on Telephone Engineering to the classes at Cooper Union, New York City.

Mr. McNicol is a collector of books and papers on electrical subjects, especially on the historical side, showing the development of electrical science and of the electrical profession, and he possesses one of the most complete private collections of works on telegraphy in the United States.

He is prominent and active in professional societies, is a member of the Magnetic Club of New York, of the American Institute of Electrical Engineers, Institute of Radio Engineers and the Telephone Pioneers Society.

ELMER P. MORRIS

Elmer P. Morris, who is engaged in the electric railway and lighting supply business at 126 Liberty Street, was early in his career associated with the installation of central stations and the construction of electric railways in various parts of the country. He was a pupil of Charles J. Van Depoele, "the father of the trolley," and from this noted electrician and inventor he gained information that was of inestimable value to him in his ensuing activities. Mr. Morris was born in Butlerville, Indiana, Friday, June 13, 1862, and this supposed unlucky combination in

the date seems to have brought him luck instead of the proverbial failure. He graduated from the Indianapolis High School in 1879, after which he went to work in the factory of E. T. Gilliland, who manufactured telephone equipment. A year later he was sent to St. Louis to do some repair work for the telephone company there. In one of the branch offices, where they had a switchboard for 125 services that took five girls to operate, he rearranged the system so that one girl could care for all 125 subscribers. From 1880 until 1882 he was with the Brush Electric Company at Indianapolis, and in 1882 he went to Chicago, where he became an employee of Van Depoele and gained further practical knowledge of electricity. He installed a number of isolated arc lamp plants in and around Chicago, and city plants at Freeport, Joliet and Bloomington, Illinois; Lansing, Michigan; Michigan City, and Brazil, Indiana, and Waco and Corsicana, Texas. In June, 1886, he was sent to Appleton, Wisconsin, to construct the electric railway system there. This was the first complete electric railroad ever built in the United States from track to power house. The first Edison Central Station was located there. After completing and starting the road he was sent to Port Huron, Michigan, to instal another line. His next operative point was Lima, Ohio, from whence he went to Binghamton, N. Y., where the first road in the State was built. The roads in Brooklyn and Jamaica next received his attention, which were followed by the lines at Ansonia, Conn., and Dayton, Ohio. He had full charge of constructing all these roads, and upon their completion he went to Boston in 1889 as the representative of the Thomson-Houston Company, now the General Electric, which had acquired the Van Depoele traction system patents. He spent a few weeks in the plant at Lynn and was then put in charge of the construction of the West End Street Railway electrification from Bowdoin Square, Boston, to Harvard Square, Cambridge. Completing this work, he equipped a road in Cincinnati, Ohio, and spent the succeeding two years in selling railway supplies, being subsequently appointed designing engineer of construction material. In this connection he organized the Electric Railway Supply Department for the company and had charge of the same for two years. He left the company's employ to enter business for himself and located at Indianapolis. In 1895, two years later, he removed his business to New York City and has since added an Export Department to its activities. Mr. Morris remained with Mr. Van Depoele until that great genius died in 1892, and he pays the highest tribute to that noted inventor, whose death, when only 45 years of age, cut short a career of more than usual brilliancy. He firmly believes the association resulted in his equipment and subsequent achievement which, in addition to installation and construction, gave him the ability to study problems that enabled him to take out a number of patents on electric specialties, some of which are standard equipment today. In connection with his long association with the industry Mr. Morris has collected and prepared considerable pioneer data pertaining to early electrical history.

Mr. Morris comes of an illustrious ancestry, being directly descended from the Robert Morris family which figured prominently in the history of state and nation. He is a member of the New York Electrical Society, the Railroad Club and the Masonic Fraternity, being a 32nd Mason, a Knight Templar and a Shriner. He resides at 411 William Street, East Orange, New Jersey.

WILLIAM S. MURRAY

WILLIAM S. MURRAY

Every traveler, habitual or occasional, between New York City and New England has observed the presence of electric power along the tracks of the New York, New Haven & Hartford Railroad, southward from New Haven along the Sound shore. The compact, box-like looking locomotives, the steel spans crossing in monotonous succession overhead are still innovations upon American railroads, though discussion is rife on the question of electrifying the entire railway system of the country. Near the cities or in densely populated sections the superiority of electric propulsion has been decisively proven and the experience of the New York, New Haven & Hartford R.R. was a case in point. It was, in fact, the first steam road to adopt electric traction and to apply it to any considerable portion of line. The degree of confidence inspired by this successful experiment led the Pennsylvania Railroad and the Swiss Government to accept the standards which had been established. The engineer, upon whom fell the actual task of electrifying the New Haven road was William S. Murray. The outcome placed his name among the foremost of the world's great electrical engineers. About a quarter of a century ago, electric motive power was just beginning to be adopted for traction purposes. In the same period, in 1895, Mr. Murray came out of Lehigh University bearing the degree of Electrical Engineer. He was then barely twenty-two years old, having been born August 4th, 1873, at Annapolis, Maryland. His keen discernment of the exacting standards demanded by the profession he had set out to master was met by a wise choice of means. The principal necessity he recognized to be the securing of a thorough working knowledge of electrical engineering construction and operation. That branch of the science bearing upon the transmission of high voltage A.C. power and its application to railway and industrial properties even then excited his ambition. Directly from the University he went to another school of learning, not so called but where instead of professors' examination papers he must meet the world's test of 100 percent results which, alas, for many college boys, seems a cruel standard. With the Westinghouse Electric & Mfg. Company he began as an apprentice at the East Pittsburgh plant. Before long he had risen to the position of testing room engineer, then became construction engineer on the road, progressing later to district engineer of New England, and finally to sales engineer. On the strength of such experience he established himself independently in Boston, Mass., as a consulting electrical engineer. That his abilities were highly regarded is a foregone conclusion in view of his having been sought by the N. Y., N. H. & Hartford R. R. company to accomplish the engineering feat already cited. He remained with the railroad as a consulting engineer after the newly electrified road was in operation. Later, as a member of the firm of McHenry & Murray, engineers, his attention was turned to water power developments on the Housatonic River in Connecticut. These valuable sites were a matter of interest to the firm. Mr. Murray entered the Housatonic Power Co. as assistant to the president, afterwards becoming president himself. Subsequently, the Connecticut Light & Power Company, a corporation composed of a merger of four companies, absorbed the properties in which McHenry & Murray were concerned and after the dissolution of the latter firm, proceeded with the projected works that are now in process of evolution. Mr. Murray took a financial as well as professional interest in the Connecticut Light & Power Co. He is today their chief engineer, but he is also known throughout the land to be a scientist whose opinions are well nigh authoritative in those branches of electrical practice upon which he has specialized. Mr. Murray makes his home at Watertown, Connecticut, while his offices are at 111 West Main Street in Waterbury. He is closely connected with local societies, being a member of the Waterbury Club, the Country Club and Rotary Club of that city. On the side of scholastic affairs he is a member of the Graduates' Club of New Haven, Conn., and of the Chi Phi Fraternity of Lehigh University. His sympathy with the fraternal organization of his profession is shown by membership in the American Institute of Electrical Engineers and Engineers' Club of N. Y.

DOUGLAS H. McDOUGALL

Douglas H. McDougall, president of the Canadian Electrical Association, the most important society affiliated with the National Electric Light Association, and Fourth Vice-President of the National Electric Light Association itself, was born at Toronto, Ontario, January 29, 1874. He was educated in the Toronto public schools and at Upper Canada College. He began his business career at the age of 16 in the service of the Grand Trunk Railway Company. After a year and a half he secured a position with the Western Assurance Company and was sent to New York in 1889 as accountant for the New York and New England branches of the Western and British American Assurance Companies. Four years later he returned to Toronto as treasurer of the Electrical Development Company of Ontario, Ltd., and had charge of the finances of this important organization from its inception. The magnificent hydro-electric plant of this company at Niagara Falls, Ontario, is one of the most notable power houses on the continent.

In 1908 the holdings of the Electrical Development Company were leased to the Toronto Power Company and Mr. McDougall was appointed assistant to the general manager of the latter. In 1911 the Toronto Power Company purchased the entire stock of the Toronto Electric Light Company, Ltd., and Mr. McDougall assumed the duties of assistant to the manager of the still further enlarged organization. At present he handles all the detail work in connection with the commercial operation of the Toronto Electric Light Company, Ltd.

In addition to holding the above offices Mr. McDougall is treasurer of the Electrical Development Company, of the Toronto and Niagara Power Company, and of the London, Ontario, Electric Company. He is also secretary of the Niagara Falls Gas and Electric Light Company, of Niagara Falls, N. Y.

In spite of his arduous professional duties Mr. McDougall has found time to be an integral part of the general life of his community. He was for some years the chairman of the Toronto section of the American Institute of Electrical Engineers, of which he is an associate member, and is a member also of the Toronto Board of Trade, The Royal Canadian Yacht Club, Canadian Club, Empire Club, Engineers' Club of Toronto, Arts and Letters Club of Toronto and the London Club, of London, Ontario. He is married and has one son.

It is but a few years since Mr. McDougall was an outstanding figure in international athletics. He was the International Canoe Champion for both single and double blade contests and holds numerous rowing trophies won as a member of the famous Argonaut Rowing Club, of Toronto, and the Clifton Boat Club, of Staten Island, N. Y.

Greatly to the credit of a man whose business obligations are so numerous, he has continuously discharged his duty to his country, having been for many years enrolled on the roster of the 48th Highlanders Regiment of Toronto in which he now holds a captain's certificate. His activities during the present war have been of a notably practical character.

Mr. McDougall's record is that of one who yet young has, by the constant application of unusual judgment and ability, risen to a notable position in Canadian affairs and has, by his manly sincerity and pleasing personality, won for himself the respect and confidence of a host of friends not only in Canada but in the United States.

CRESCENT ELECTRIC AND MANUFACTURING COMPANY

JACOB F. MOTZ, President

The Crescent Electric and Manufacturing Company, of Pittsburgh, Pa., while having a most complete service in the general repair of electrical equipment, specializes in the rewinding and reconstruction of dynamos and motors of all systems, as well as the refilling of commutators, general motor repairs and wiring for light manufacturing purposes. The company was established in 1899 and incorporated in 1902. It was recently completely re-organized under the management of J. F. Motz, president, and A. L. Dole, secretary-treasurer, two men of experience, who have largely increased the business and placed it among the sound industrial plants

of the Western Pennsylvania City. A short time ago the company absorbed the Pittsburgh Armature Works by the purchase of its equipment and stock, and this gives the Crescent Company increased facilities along this line of electrical work for extending its already large business. Experienced men are supplied anywhere in the Pittsburgh district for any work included in the company's line. The experts in the company's service are frequently called into consultation by large business interests, and advice is cheerfully given on any problem submitted.

EDWARD J. NALLY

Edward J. Nally, President of the Marconi Telegraph-Cable Company, Inc., and Vice-President and General Manager of the Marconi Wireless Telegraph Company of America, who has for years been a conspicuous figure in telegraph and telephone work, may well be considered a pioneer in these different modes of communication. He has risen from an humble position by merit and close application, and the many years of his business activity are filled with notable achievement.

Mr. Nally was born in Philadelphia, Pa., April 11, 1859, and had opportunity for but a few years of schooling, as he had to work as a cash boy at the age of eight, on account of his father losing his eyesight. At the age of fifteen he was a messenger boy for the Western Union Telegraph Company, in St. Louis, Mo. He next became office boy for Col. Clowry, late president of the Western Union, and later assistant to I. McMichael, who was superintendent for that company in St. Louis and Minneapolis. He remained in this position until October, 1890, when he was made assistant general superintendent for the Postal Telegraph-Cable Company, with headquarters in Chicago, and two years later was appointed general superintendent. In this position he had jurisdiction over the telegraph lines and offices of twenty-two states. In 1906 he was transferred to New York City, as vice-president, and later elected first vice-president and general manager and a director of the company, continuing as such until 1913, when he was offered the office of vice-president and general manager of the Marconi Wireless Telegraph Company. He is also a director and member of the executive committee of that company, and a director and member of the executive committee of the Marconi Wireless Telegraph Company of Canada. He is also president of the Marconi Institute, the Wireless Press and the Pan-American Wireless Telegraph and Telephone Company.

While in St. Louis Mr. Nally was temporarily in charge of the first Edison telephone exchange, when the Edison telephone was owned and operated by the Western Union Telegraph Company.

In his official capacity Mr. Nally has visited practically every town and hamlet in the United States. He prepared the estimates for the first telegraph lines to follow all of the transcontinental railroad lines constructed during the years 1880-1900 and the opening and operation of thousands of telegraph offices throughout the land. The entire system of the Postal Telegraph-Cable Company in the middle and far West was built during Mr. Nally's time as general superintendent in Chicago, and in the Southwest after his transfer to New York.

Since his association with the Marconi Wireless Telegraph Company of America he organized the company for commercial service, and just before the outbreak of the European war he arranged for the first transatlantic wireless telegraph service between the United States and Europe. In 1914, under his management, a commercial service, by wireless, was started between California and Hawaii, and in October, 1916, the first wireless commercial circuit was opened to the public between the United States and Japan. At this time there are being completed similar high-power stations in Massachusetts for work with Norway; also a chain of stations in Alaska for commercial telegraph business with the United States.

In December, 1917, he organized the Pan-American Wireless Telegraph and Telephone Company, which will construct

EDWARD J. NALLY

a chain of high power stations which will connect up the United States with Mexico, Central and South America, for commercial wireless communication. This will be the first wireless service between the countries of South America and the outside world.

It will thus be seen that the term pioneer in connection with Mr. Nally's work is no misnomer. The consummation of his life work in the development of wireless telegraphy is one of the greatest achievements of his busy career, and, in contrast to the time when, as the only all-night messenger boy in St. Louis, he tramped weary miles in the delivery of telegrams and press reports, it may well be considered marvelous.

Mr. Nally is greatly interested in gardening and the collection of books and

prints and of data relating to telegraphy. He is the possessor of a very fine collection of books, etchings and engravings; also of letters, instruments, etc., including a complete scrapbook, formerly belonging to Prof. Samuel F. B. Morse, on the invention of the telegraph. He also devotes much time to civic betterment and everything that tends to improve the condition of the worker. He has been instrumental in establishing savings and investment societies, employees' libraries and reading and rest rooms in various offices of the companies with which he has been associated.

Mr. Nally is a member of the Caxton Club and of the Brothers of the Book, Chicago; the American Geographic Society, the National Geographic Society, the American Irish Historical Society, the Institute of Radio Engineers, the Pennsylvania Society, the City Lunch Club, and is interested in several organizations devoted to the telegraph and the welfare of telegraph employees. He was married in Lexington, Kentucky, June 10th, 1897, to Lee Warren Redd, and they have two children: Marylee and Edward Julian Nally, Jr.

LOYALL ALLEN OSBORNE

The world moves so fast in the direction of progress and development that we who live in this period accept as if they always had been, things that are really but of yesterday and yet have already become of the warp and woof of our daily life.

Cynical old Thomas Carlyle, who always depreciated the value of physical improvements, used to dismiss the suggestion that Watt, Stephenson, Fulton and Morse had brought great progress to the world by contemptuously referring to their achievements as "mere smithy work." But we, who live in the age of electricity, which had scarcely dawned when Carlyle died, are all ready enough to admit that the great electrical engineers who have so wrought as to greatly multiply and expedite our resources in light, heat, power, locomotion, and the means of intercommunication of ideas have made themselves benefactors of the age of civilization.

The Story of Electricity is a story of marvels, of the accomplishment of what has passed for centuries as impossible, and of great physical benefits which we enjoy far beyond any within the reach of our forefathers. The electrical engineer who has mastered his profession belongs to the most useful class of producers. Men like Loyall Allen Osborne, who, fortified by a sound technical training, go out into the engineering profession and win their way step by step to the top, are of a kind most useful to the community, and are laying foundations for the progress that is to bless future ages.

Mr. Osborne was born June 22, 1870, at Newark, New Jersey, the son of Frederick Allen and Eliza Jane (Rathbone) Osborne. Both through the Osborne and the Rathbone strains of descent, he is a scion of old English families that transplanted to American soil have developed into the best class of American citizenship.

Mr. Osborne received his education in the high school of Newark, New Jersey, and from there went to Cornell University, where he completed scientific and technical courses and was graduated with the degree of M. E. in the Class of 1891.

Immediately following his graduation, Mr. Osborne became a member of the engineer staff of the Westinghouse Electric and Manufacturing Company. That great concern was then developing a large and progressing enterprise which was introducing new and valuable improvements in the various applications of electricity, and especially with the alternating current as applied to lighting circuits. It became and has remained one of the foremost of the greater electrical manufacturing enterprises, employing engineers of genius and skill, whose efforts and researches added constantly to the improved electrical machines and appliances produced by that company. Among those thus aiding in this progress none worked more effectively than Mr. Osborne. In four years he had advanced to a position as assistant superintendent, and after two years in that position he became assistant to the

LOYALL A. OSBORNE

vice-president, in 1897. He became manager of works in 1899, fourth vice-president in 1902, and in that office he was in active charge of the engineering and manufacturing branches of the company's business, which had by that time enormously expanded. Mr. Osborne, in his make-up and experience, possessed and improved the capacities that fitted him for management not only of engineering and manufacturing, but also of the commercial branch of the business. He had been made third vice-president in 1904, and in 1906 he was advanced to the position of second vice-president of the company, in which connection he had full charge of the selling and commercial departments. He is now in point of service the senior vice-president of the Westinghouse Electric and Manufacturing Company, in whose employ he has been at the active head of the various departments and has acquired a complete mastery of the diversified activities of that great enterprise. He has contributed in an important degree to its upbuilding, and has devoted enthusiasm and ability to its development, taking a creative part in the direction of its affairs. He is identified with the management of the company's subsidiaries and affiliated organizations, and is known to the electrical world as one of the leaders in the electrical engineering and manufacturing fields. Mr. Osborne, aside from his duties as an officer of the Westinghouse Electric and Manufacturing Company, has been actively identified with the creation and administration of the National Industrial Conference Board, being Chairman of its Executive Committee.

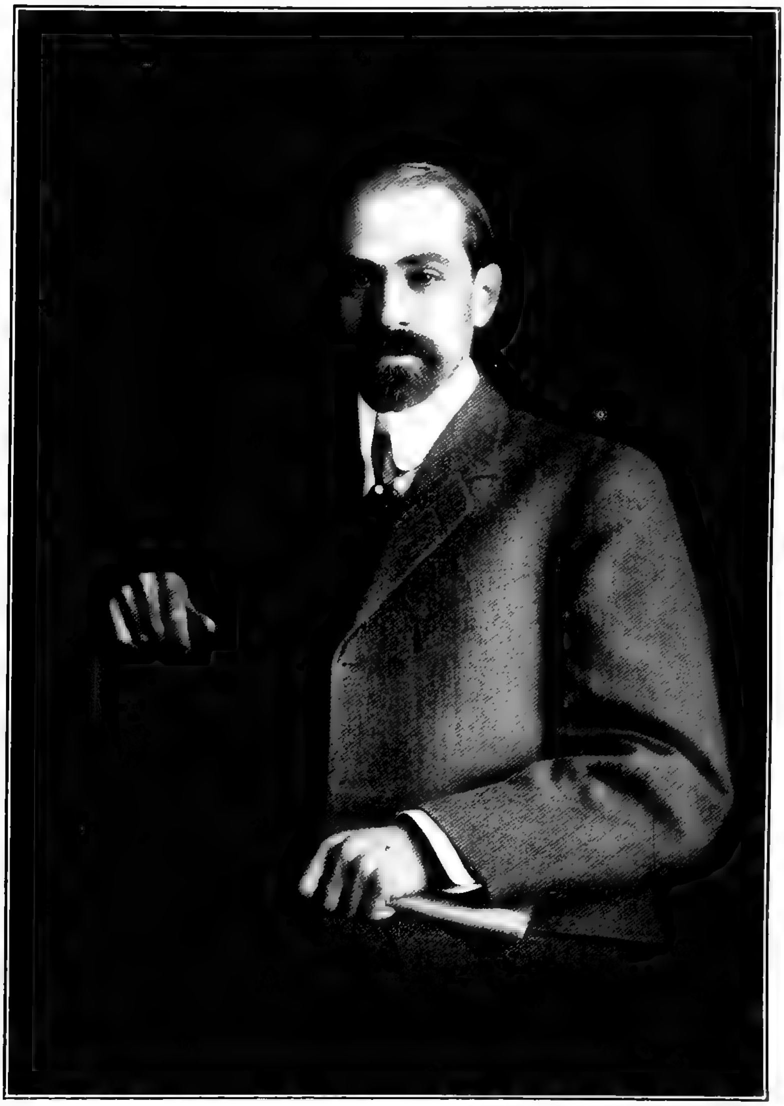
In connection with the work incident to the great war, he has served as Chairman of the Committee to the Council of National Defense, advisory to that body on industrial and economic subjects arising out of its war program. He is also a member of the Industrial Relations Committee of the Chamber of Commerce of the United States.

He was one of the employers selected to represent that group on the War Labor Planning Commission and was later appointed by the President to be a member of the National War Labor Board, created to carry out the program recommended by the War Labor Commission and designed to provide a means for the adjustment of industrial controversies during the war.

Mr. Osborne is a member of the American Institute of Electrical Engineers, the American Electrochemical Society, the Society for the Promotion of Engineering Education, the American Association for the Advancement of Science, the National Geographic Society, and other scientific societies, the National Civic Federation and the Chamber of Commerce of New York. He is a member of the Duquesne and University Clubs of Pittsburgh, Pa., the University, Railroad, Cornell, Bankers, Machinery Clubs of New York, the Lenox Club of Lenox, Mass., the Stockbridge Golf Club of Stockbridge, Mass., and the Colony and Nyasset Clubs of Springfield, Mass.

MAURICE A. OUDIN

Maurice A. Oudin is a son of the late Professor Lucien Oudin and Sophie Josephine (Agnus) Oudin. He was born in New York City March 31, 1866, and graduated from the College of the City of New York, with the A.B. degree, in 1885. He afterwards entered Princeton University, and finishing his studies in 1891 was awarded the degree of Electrical Engineer and Master of Science. He then joined the forces of the Thomson-Houston Company at Lynn, Massachusetts, and continued with the General Electric Company, its successor, filling various positions until appointed Vice-President of the International General Electric Company, a subsidiary of the General Electric Co. He has traveled extensively in foreign countries for the General Electric Company. His familiarity with European, South American and Far Eastern conditions has made him an authority on foreign trade matters and international economics. He has been instrumental in advancing the foreign trade relations of the country and his knowledge of foreign affairs has caused



MAURICE A. OUDIN

him to be consulted on international matters, especially those relating to the Far East. Mr. Oudin was decorated by the Emperor of Japan in 1911 with the Order of the Rising Sun. He is a member and one of the organizers of the National Foreign Trade Council; of India House, New York City, of which he was a founder and Governor in 1916-19; a member of the Board of Directors of the American Manufacturers' Export Association; of the University Club of New York; of the Century Club of New York; Bankers' Club of America; Electrical Manufacturers' Club of New York; Mohawk Club and Mohawk Golf Club of Schenectady, N. Y.; Japan Society; American Asiatic Association and the American Institute of Electrical Engineers. Mr. Oudin is the author of "Polyphase Apparatus and System" and has contributed many papers to the literature on foreign trade problems. He was married December 31, 1895, to Susan Worth Folger, of Geneva, N. Y., daughter of the late Charles J. Folger, Secretary of the Treasury under President Arthur, and Chief Justice of the Court of Appeals of New York.

ALMON D. PAGE

The measure of the abilities of A. D. Page and their result is not to be judged by the brevity of this account, but might better be adduced from the books of the Edison Lamp Works of the General Electrical Company whose sales policy he has directed since 1890. His experience goes back to 1880 and a connection with the M. C. Bullock Company, Western agents of the Brush Electric Light. He afterward became superintendent of James P. Marsh & Company of Chicago, and was with the United Edison Co., at 65 Fifth Avenue, New York, in 1889. Mr. Page is from Michigan, born at Litchfield, Feb. 27, 1860, and he attended Albion College. He is an associate member of the American Institute of Electrical Engineers, and a member of the Illuminating Engineering Society and the Engineers' Club of New York City. Mr. Page's offices are with the Edison Lamp Works at Harrison, N. J., and 120 Broadway, New York City.

RAY PALMER

Ray Palmer, president of the New York & Queens Electric Light and Power Company, which serves one hundred and eight square miles of territory in New York City, was formerly Commissioner of Gas and Electricity of Chicago, Ill., and in that capacity evolved and completed the most nearly perfect system of municipal lighting in the world. In addition he reorganized the Departments of Gas and Electricity into separately working divisions, Electric Wiring and Repairs, Operation and Maintenance, Engineering and Construction, Lighting, Fire Alarm and Electrical Inspection, which work resulted in a large saving to the city; and in addition Mr. Palmer fought incessantly for the passage of an electrolysis ordinance, which was opposed by the street and elevated railways, but was finally passed. It conferred

many benefits and saved the city and the public utilities large sums each year. After resigning from the position of Commissioner of Gas and Electricity, Mr. Palmer practiced his profession in Chicago for a short time when he was chosen vice-president and general manager of the New York and Queens Company November 1, 1915, and was advanced to the presidency September 19, 1916. Mr. Palmer was born in Sparta, Wis., March 29, 1878, and graduated from the University of that State in 1901 as an electrical engineer. He was for a time assistant superintendent for J. G. White & Co., on substation installation work of street lighting in New York City, and after the completion of this work continued on the firm's engineering staff in London, Eng. He was later appointed electrical engineer of the Union Traction Co. of Chicago but left that organization to start in the engineering business as a consulting engineer in Chicago and Milwaukee, and continued in private practice until his appointment in the Western metropolis by Mayor Carter Harrison. Mr. Palmer is a Fellow of the American Institute of Electrical Engineers and a member of the Electric Club of Chicago, the Engineers' Club of New York, the Illuminating Engineering Society and the New York Electrical Society. His address is 444 Jackson Avenue, Long Island City, New York.

HAROLD PENDER

Dr. Harold Pender is a native of Tarboro, N. C., where he was born January 13, 1879. He was educated in the Baltimore public schools, McDonogh School, McDonogh, Md., and Johns Hopkins University, from which he was graduated A.B., 1898, and Ph.D., 1901, and was assistant in the Physical Laboratory of the University, 1899-1901, instructor at McDonogh School, 1901-1902, and instructor in physics, Syracuse University, 1902-1903; entered apprenticeship course of Westinghouse Electric and Manufacturing Company, May, 1903; given regular position on company's engineering staff in Fall of 1903, in charge of testing sheet steel for electrical purposes. Was assistant, 1905-1909, to Cary T. Hutchinson, consulting engineer (New York), and his assistant when he was chief engineer of the McCall Ferry Power Company, 1907-1909. Was in faculty of Massachusetts Institute of Technology as Professor of Theoretical and Applied Electricity, 1909-1912, of Electrical Engineering, 1912-1913, and Director of Research Division of Electrical Department, 1913-1914; since 1914 Professor in Charge, Department of Electrical Engineering, University of Pennsylvania.

Valuable contributions to electrical science by Dr. Pender include exhaustive experiments made in this country and France, proving Maxwell's theory that a moving charge produces a magnetic field, a postulate absolutely fundamental to the modern theory of electricity, as well as many experiments and reports on large electrical and related hydraulic and economic problems, connected with great electrical undertakings.

DAVID M. PETTY

David M. Petty, superintendent of the Electrical Department of the Bethlehem Steel Company, was born March 2, 1885, at Archdale, North Carolina. His father's and mother's people are Quaker families long resident in North Carolina. The Pettys have been there for generations and before that were residents of Nantucket Island, where they were among the original settlers. His mother's people (Tomlinson) settled in North Carolina in Colonial days, by virtue of a grant from the King of England. Mr. Petty was graduated B.S. from Guilford College in 1907, and from Lehigh University with the degree of E.E. and election to Tau Beta Pi in 1909. Before entering Guilford College in 1904 he had worked a year in the hydro-electric plant of the Fries Manufacturing and Power Company at Winston-Salem, N. C. During the summer vacation periods of 1907 and 1908 he worked in the test-room of the Crocker-Wheeler Company, at Ampere, N. J. Being especially attracted by steel mill electrical engineering as a new and developing field, he started at once after graduation as a repairman with the electrical department of the Bethlehem Steel Company. He advanced in that service until he was made superintendent of the department in 1912. Since that time

DAVID M. PETTY

many shops have been built using individual drive on all machine tools, and rolling mills, both reversing and non-reversing, all using electric drives. The notable progress and development of the Bethlehem Steel Company, the enlargements of its operations and capacity, have been greatly aided by the introduction of electricity to all the appropriate processes of steel making, and this work has afforded excellent opportunity for Mr. Petty's skill in this branch of engineering. He is a member of the American Institute of Electrical Engineers, Association of Iron and Steel Electrical Engineers (first vice-president, 1917-1918; president, 1918-1919), and the Engineers Club of Philadelphia. He is also a member of the Bethlehem Club, University Club (president, 1917-1918) and Gahnwa Club (commodore, 1917-1918), all of Bethlehem, Pa.; also a member of the Bethlehem Chamber of Commerce, Knights of Pythias and is a thirty-second degree Mason.

MARSDEN J PERRY

MARSDEN JASIEL PERRY

Among the earliest towns planted in New England was Rehoboth, in the Plymouth Colony. In 1641 the land was bought from Massasoit by John Brown and Edward Winslow. The town was planted in 1643, and Anthony Perry, among the fifty-eight planters, was the sixteenth who joined in the settlement. On the 4th of March, in the fourth year of the reign of King Charles the First, the Colony of Massachusetts Bay in New England was given a charter, and twenty-six men were named as grantees. The fourteenth was Richard Perry, and the twenty-first was John Brown. The descendants of these two Englishmen were among the original planters of the town of Rehoboth and they intermarried. From these lines there came many descendants. To one of them, Horatio N. Perry, a son was born in 1850, in a small house standing upon the land which his great-grandfather cut into eight parts and divided among his eight children. This house was the third built in the locality by Anthony Perry and his descendants, since the land was bought from the Indian Chief. The child was given a name brought to New England by the very earliest of these men, Marsden Jasiel Perry. When three years of age his father died, and soon his mother married again and the child went to live with his grandmother, Lucy Perry. This grandmother, and her two sisters, had been, and then were, teachers in the schools, and some of her five brothers were preachers among the Methodists.

Young Marsden must have been a child with the sense of observation very strongly developed. Besides his natural gift of concentration the loneliness of his life further developed this trait, for it has strongly characterized his life. In his twelfth year the boy bethought himself that the time was approaching when he should go forth among men, and himself prepare to be a man—"shift his being," as Cymbeline's Queen spoke it. He went, and worked, and at last, near the close of the War of the Rebellion, enlisted in a Massachusetts Company and was sent to Boston. There he was detailed to a position in the office of the Provost Marshal. At the State House the boy was brought in contact with the great war Governor of Massachusetts, John Albion Andrew. The office of the Provost Marshal was near the room where the Governor worked day and night for his country, and young Perry soon became familiar with the new surroundings and felt himself at home in the long narrow corridor that led from the Council Chamber to the Governor's room.

The 3rd of July, 1863, was a day of importance in his life, as it was in the life of the Governor. Andrew had promised to pass the Fourth of July in Salem at the house of Mr. Rantoul, when late in the afternoon of the 3rd of July he found that he was expected to make a speech the next morning at the dedication of the statue of Horace Mann in the grounds of the State House. To write this he needed many books of reference from the state library, and a boy to bring these books was demanded. Who so readily to respond as the bright-eyed boy from Rehoboth, in the Provost Marshal's office? All those long hours, when the great Governor was writing his famous speech which was to ring throughout the whole state and rouse the friends of Webster and of Mann to fresh controversies, the lad went back and forth from the Governor's room to the state library bringing books.

In 1871 young Perry went to Providence, R. I., to find an occupation and to live. His head and hands were his only capital. For ten years, 1871-1881, Mr. Perry worked with other men. He then reversed the operation, by leading other men to work with him; and then began the great business career which he has steadily followed. In that year he organized his first corporation, became its President and controlled it for eight years. He then sold his interest, and the company was merged into one of the modern consolidations. In this same year, 1881, Mr. Perry became a director in the Bank of America. This bank then had assets of $287,000. It is now the Union Trust Company, its home is a magnificent twelve-story block and Mr. Perry is the chairman of its Board of

Directors. Its assets are more than twelve millions of dollars.

In these days of great industrial and scientific advance, fortunes come to him whose mind is so constructed as to quickest see the possibility of the application of these results of scientific research to industrial methods. It was the possession of this gift which led Mr. Perry, in 1882, to acquire control of the Fall River Electric Lighting Company, which for some years he held and then sold to a syndicate. So, too, in 1884, he led two other men to join him in the purchase of the Narragansett Electric Lighting Company of Providence. No sooner did he get this plant into working order than he saw clearly the future development of electric power, and how it might be applied to a railroad, or any other enterprise where power was needed. It was this gift of foresight which led him, with two friends, to buy the Union Street Railroad, in Providence, his purpose, as soon carried out, being to use electric instead of horse-power.

Mr. Perry has been for twenty-five years a director in the Nicholson File Company, the largest file producing company in the world, and of the General Electric Company and many other corporations.

In 1896 the United States Circuit Court appointed Mr. Perry a joint receiver with Senator Platt, of New York, of the New York and New England Railroad Company. These men saved the road from annihilation, and restored it to the stockholders.

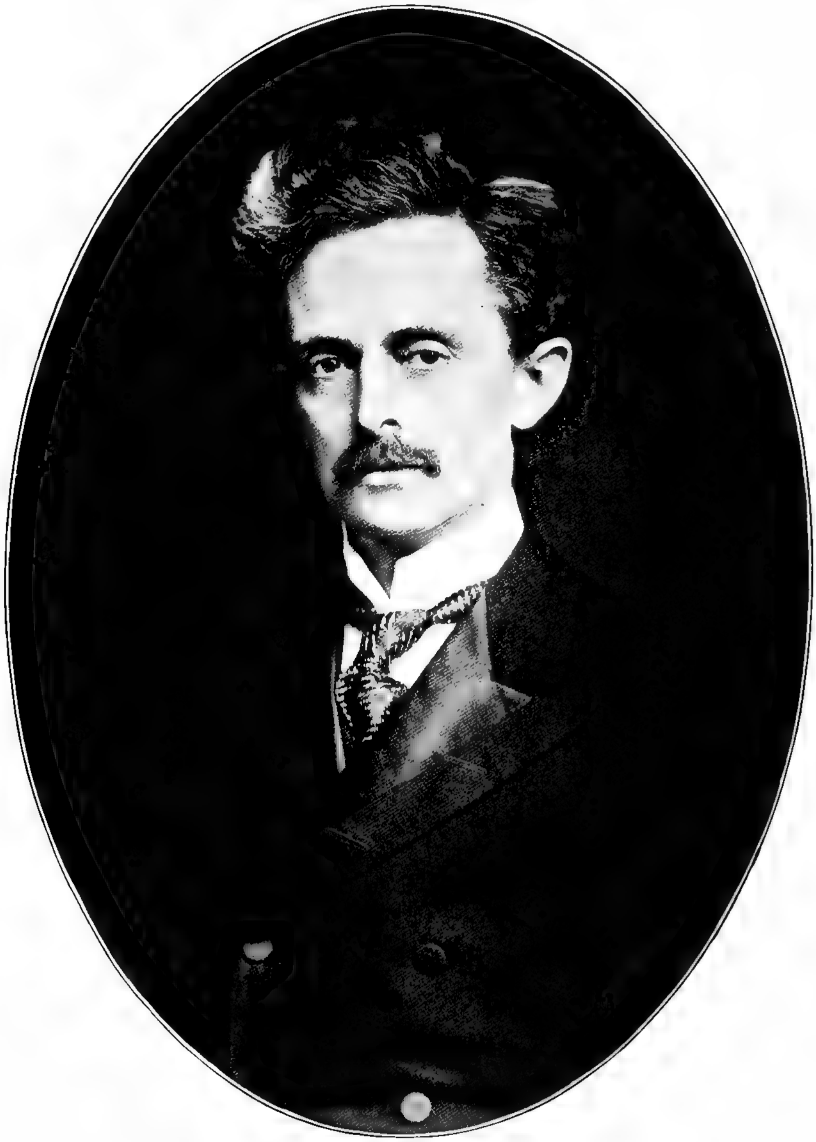
Among the greatest of the works of Mr. Perry is his development of suburban electric railways over Rhode Island and entering Massachusetts. This work began with the Interstate Railway Company in 1895, then bankrupt and in the hands of receivers. It is now a most important and valuable factor in the communities it serves.

During the years in which he was doing these material things, Mr. Perry was also engaged in collecting a Shakespearian library. In searching his grandmother's library one day, young Perry, in pulling a book from a shelf, saw behind it another book, apparently hidden. Child-like, he pulled out the book. It was the works of William Shakespeare. It had doubtless been hidden, in dread fear of contamination, by its faithful and conscientious owner. The boy took Shakespeare's Plays to his sleeping room, and every spare moment for many weeks was spent in reading them. From this incident came one of the greatest collections of Shakespearian literature now in existence. Mr. Perry has also collected the works of Albert Dürer, the father of the art of engraving, who died in 1528, and the etchings and original drawings of Rembrandt, and the writings of William Morris, the modern English poet-decorator.

From his youth a love of beauty has been one of Mr. Perry's leading characteristics. His collection of Chinese porcelains was one of the most famous a few years ago. His home, the John Brown house on Power Street, Providence, is the best example of colonial architecture in the State of Rhode Island and one of the finest in the country. It contains magnificent collections of Chippendale, Sheraton and Colonial furniture. Mr. Perry is a member of the Walpole Society, an association of connoisseurs who have the pleasant custom of making several jaunts each year to visit some famous artistic monument. Twice within a few years the Club visited Mr. Perry's house on Power Street, and these visits were pronounced by the members as second to none in interest. Eleven years ago Mr. Perry acquired a Newport estate on the Ocean Drive called Bleak House, occupying one of the most coveted sites on this famous drive. This part of the island had been considered by all Newporters as being a spot impossible to cultivate on account of the strong winds that blow across it from the Atlantic Ocean. With the same sort of tenacity that has characterized his business career Mr. Perry tackled this horticultural problem, with the result that he has made the desert bloom like a rose. Not satisfied with beautifying this unique summer home for his family, Mr. Perry, a few years since, became interested in The Art Association of Newport, founded by a few of the artists and art lovers of Newport. To this group of workers Mr. Perry has brought the same constructive talent. He became the friend of the Association and was soon elected chairman of the Committee on Buildings and Grounds. The Association is now one of the most important public institutions of Newport.

ELLIS LAURIMORE PHILLIPS

Ellis Laurimore Phillips, who has had, since his graduation from Cornell University in 1895, a large and varied experience in every phase of electrical work, was born at Naples, N. Y., March 1, 1873. He attended the Naples High School before taking his course in Electrical Engineering at Cornell and after graduation became a draftsman with the De Laval Separator Company, Poughkeepsie, New York. At different periods Mr. Phillips was connected with electrical railway construction and the erection of a number of refrigerating and electric plants. He was for seven years engineer for Westinghouse, Church, Kerr & Co., and during this period had engineering charge of construction of the Grand Rapids, Grand Haven & Muskegon Railroad, the Detroit, Ypsilanti, Ann Arbor and Jackson Railroad, and the Lackawanna & Wyoming Valley Railroad. Mr. Phillips' ancestors are from New England, being among the earliest settlers of the State of Connecticut. His entry into the field of electric endeavor was the result of natural inclinations, he having from boyhood been attracted by the mystery and possibilities of the science which at that period was being developed as a commercial proposition. In addition to the presidency of E. L. Phillips & Co., engineers, he is president of the Long Island Lighting Company, president of the Northport Water Works Company and vice-president of the Warsaw Gas and Electric Company. He is a member of the Cornell Club, Machinery Club, Huntingdon Golf and Marine Club, New York Electrical Society, American Society of Mechanical Engineers, American Society of Refrigerating Engineers and the American Association for the Advancement of Science. Mr. Phillips' business address is 50 Church Street. He resides at 575 Riverside Drive.



FRED STARK PEARSON (deceased)

All electrical engineers will be interested in recalling the life of Fred Stark Pearson, cut short at the zenith of power by the appalling Titanic disaster. No single accomplishment of his career is more notable historically than the electrification of the New York street railways. When in 1894 Mr. Pearson was called to accept the position of chief engineer of the Metropolitan Street Railway Company, he had already successfully introduced electric street railway systems in New England. But for the special requirements of the metropolis he made investigations of roads in European cities, and the result of his studies was the system of underground conduits, which proved so eminently practicable. Mr. Pearson's early life was spent in New England, where he was born, at Lowell, Mass., in 1861. He acted as consulting engineer to many railway and power companies, both in the United States and abroad, and represented American and foreign syndicates in engineering construction involving million of dollars. Near the close of his life he was president of the Pearson Engineering Corporation.

CHARLES B. PRICE FRANK S. PRICE

PETTINGELL-ANDREWS COMPANY

CHARLES B. PRICE, *Chairman*

FRANK S. PRICE, *President*

Charles B. Price, chairman of the board of directors of the Pettingell-Andrews Co., dealers in electric appliances, was born October 22, 1869, in Salem, Mass. He was educated at the public schools in the city of his birth and at a commercial school in Boston. He left high school at the age of sixteen, and entered the drug business in Salem. He retained this position for four years, when, realizing there was little future in that line, he went to Boston and entered the employ of the Pettingell-Andrews Co., rising steadily until he reached his present position. In addition to his interest in this company, he is a director of the Phillips Insulated Wire Co., Pawtucket, R. I.; Salem Electric Light Co., Holyoke Mutual Fire Insurance Co., and the Naumkeag Trust Co., all of Salem. He is a devotee of golf, hunting and fishing, and is a member of the Algonquin Club and the Exchange Club of Boston, the Eastern Yacht Club, of Marblehead; the Tedesco Country Club, of Swampscott, and the Metabetchowan Fishing and Game Club, of Canada.

The origin of the Pettingell-Andrews Company, with which Mr. Price is connected, dates back to 1886, when F. E. Pettingell associated with him a man by the name of Armstrong, and organized the firm of Pettingell & Armstrong, as manufacturers' agents, having an office at 95 Milk Street, Boston. Mr. Armstrong remained less than a year, and in 1887 the firm name was changed to F. E. Pettingell & Company.

In 1888 Mr. Pettingell became associated with D. A. Andrews, and the firm name was then changed to Pettingell, Andrews & Company. In the meantime the firm had moved to the corner of Congress and Franklin streets.

In 1889 they moved to 196 Summer street. Mr. Charles B. Price entered the employ of the firm in 1889, shortly after they moved to the Summer street address. In 1890 Mr. Charles B. Price was admitted as a member of the firm, the firm name remaining the same—Pettingell, Andrews & Company. Later in the same year the company was incorporated and the name changed to Pettingell-Andrews Company, F. E. Pettingell being president; D. A. Andrews treasurer; Charles B. Price, secretary.

During 1893 F. E. Pettingell severed his connection with the company, and D. A. Andrews passed away.

By 1894 the company had outgrown its quarters and moved to 72 Federal street. During 1894 Mr. Frank S. Price entered the employ of the company.

During this period the company had closely identified itself with the Phillips Insulated Wire Company of Pawtucket, R. I., Mr. Phillips of the latter concern becoming one of the directors of the Pettingell-Andrews Company, and Charles B. Price becoming a director of the Phillips Insulated Wire Company.

In 1897 Charles B. Price was elected president and Frank S. Price secretary.

By 1898 the business had grown to such an extent that the company was obliged again to seek larger quarters, and moved to 5 Winthrop Square. By 1902 the company had outgrown its location in Winthrop Square, and in the fall of that year moved to its present location, corner of Pearl Street and Atlantic Avenue, since which time two additional buildings have been added, so that at the present time the company occupies three buildings—the main building, with offices, being located on the corner of Pearl Street and Atlantic Avenue, the stock rooms, warehouses, etc., being in the adjoining buildings on Atlantic Avenue and Purchase Street.

In 1913 Frank S. Price was elected president. At the present time the officers of the company are as follows: Charles B. Price, chairman board of directors and treasurer; Frank S. Price, president; William J. Keenan, vice-president; George J. Murphy, secretary.

The company has always represented in the New England States the leading manufacturers of the various electrical lines throughout the country, among which are the following: Phillips Insulated Wire Company, Pawtucket, R. I.; Okonite

Company, New York City; the Locke Insulator Mfg. Co., Victor, N. Y., and the General Electric Company. It is the oldest electric supply house east of Chicago, and by far the largest in New England.

Frank S. Price, president of the concern, was born in Salem, Mass., November 8, 1875. He was educated at the Dummer Academy, and after finishing his course, entered the employ of the Pettingell-Andrews Company. He readily adapted himself to the business, and in 1897 was made secretary. His elevation to the presidency was in 1913, and since that period the entire business of the large establishment has been directed by him and his brother, the chairman of the board. Mr. Price holds membership in the Algonquin and Exchange Clubs of Boston, the Tedesco Country Club, the Illuminating Engineering Society, National Electric Light Association, Jovian Order, and is a director of the Society for Electrical Development.

HENRY WATERMAN PECK

An unusually broad technical education and a wide practical experience both in electrical engineering and on the commer-

HENRY W. PECK

cial side of electric and gaslight service have brought prominence to Mr. Henry Waterman Peck in the field of illumination. He was born in New Britain, Conn., July 7, 1877. He was educated in the New Britain High School, graduated from Yale 1897, with first prize in German and election to Sigma Xi, and from Cornell in 1900; and he took the course in civil engineering at Yale and in electrical, mechanical and mining engineering at Cornell.

He practised civil engineering with S. E. Minor, Greenwich, Conn., July, 1897, to September, 1898. In December, 1900, he entered the employ of the Westinghouse Electric and Manufacturing Company, Pittsburgh, as special apprentice until February, 1902, and then became switchboard engineer with that company until he entered, in May, 1906, the Consolidated Gas, Electric Light and Power Company, of which he was assistant superintendent of operation until November, 1907, then became assistant electrical engineer of the Rochester, N. Y. Railway and Light Co., in charge of commercial engineering chiefly, until May, 1911, and after that until February, 1912, was assistant to the general manager. Since February, 1912, he has been vice-president and general manager of the Schenectady Illuminating Company and the Mohawk Gas Company of Schenectady, N. Y. He is a member and was president two terms of the Schenectady board of trade, president of the Schenectady board of education; vice-president of the Empire State Gas and Electric Association; fellow of the American Institute of Electrical Engineers; member American Society of Mechanical Engineers, American Gas Institute, National Electric Light Association, National Commercial Gas Association, Mohawk Club, Mohawk Golf Club and the Schenectady Historical Society.

MICHAEL IDVORSKY PUPIN

MICHAEL IDVORSKY PUPIN

When Prof. Michael Idvorsky Pupin came to this country an immigrant forty five years ago, he had an abiding faith in his ability to make his way in the world, but had no thought of becoming one of the world's savants through his electrical research. Prof. Pupin was born in Idvor, Banat, Hungary, October 14, 1858, and ran away from home to come to America. After arriving at Castle Garden he worked as a farm hand in Delaware and Maryland and drifting back to New York, he worked during the daytime and studied assiduously at Cooper Institute in the evenings. He saved enough to enter Columbia University and at the end of the freshman year he won two first prizes in Greek and Mathematics. This was a great help to him. He got through his sophomore year with less difficulty and when he graduated with the A. B. degree in 1883, he had saved enough money to go abroad and study Physics and Mathematics. He was given the Tyndall fellowship by Columbia in 1885. This yielded $650 a year and the University induced him to return to this country in 1888 to aid Prof. Crocker in establishing a course in electrical engineering. This position gave Prof. Pupin a free hand to conduct his research work, which he took up through love of study of the phenomena relating to exact physical sciences. Among his discoveries is that of secondary X-ray radiation; discovery of the law of equivalence between uniform electrical conductors and those made up of periodic structure and the application of this discovery to long distance telephone work by constructing distortionless cables and overhead lines. This made the New York-San Francisco telephonic transmission possible, also the Boston-Washington transmission over an underground line; also the application of electrical resonance to telephony and telegraphy, particularly wireless telegraphy. The results of this work were the inventions in electrical tuning practiced universally to-day in wireless telegraphy. They were patented, the Marconi Company buying the patents in 1902. Prof. Pupin received the French Academy Hebert Prize for these achievements and he values this highly, as it is very seldom awarded by the Academy to men born outside of France.

When wireless telegraphy became prominent in 1896, he invented a simple method of electrolytic rectification of high frequency oscillations at the receiving station; this general method of receiving wireless signals, that is, the rectification of high frequency oscillations, is now in universal use, in the vacuum tube rectifiers. His work in electrical discharges in rarefied gases led him to take up the study of the X-ray; he was the first in this country to repeat the Roentgen experiments and the first to use X-rays practically for surgical purposes.

This X-Ray work interfered with Pupin's health, so he abandoned it for the study of electrical transmission of power and in particular the mathematical theory of sectional electric conductors. The outcome of this work is the well-known "Pupin-Coil," now universally used in telephony and telegraphy. This invention of Pupin's has done more to extend the sphere of telephonic work than all other inventions together, since the original invention of the telephone. Striking illustrations of the value of this invention are the existing New York-San Francisco telephone line, the Boston-Washington underground cable line, and the submarine cable between England and Holland—all of these are impossible without the "Pupin-Coil."

This same mathematical theory of sectional conductors is applicable to wireless telegraphy; Pupin has developed it during the last ten years for the solution of several important problems in wireless telegraphy. He has just now completed the most important of these—probably more important than the "Pupin-Coil" in its value to mankind, although perhaps not nearly as important from the point of view of money. What he has now found and will soon announce to the world is a perfect method of eliminating "static" interference with wireless transmission, the great drawback of wireless. Under present conditions, it is often impossible to get messages through for days at a time, and at all times of the year, during portions of

the day transmission is impossible. The vital importance of this invention to this country in time of war is obvious.

Prof. Pupin is a member of many scientific bodies. He is a Fellow of the American Association for the Advancement of Science and the New York Academy of Sciences, a member of the American Philosophical Society, the American Mathematical Society, the American Institute of Electrical Engineers, the National Academy of Sciences, and a corresponding member of the Royal Serbian Academy. The University of Berlin conferred the Ph.D. degree upon him in 1889, Columbia honored him with the Sc.D. in 1904 and the Johns Hopkins University made him a Doctor of Laws. He has been Professor of Electro-Mechanics at Columbia University since 1901 and he is also director of the Phoenix Research Laboratories, attached to the same institution.

LOUIS MAXWELL POTTS

It was the good fortune of Louis Maxwell Potts to be intimately associated with the great scientist, Prof. Henry A. Rowland, studying under him, assisting in the development of the Rowland system of telegraphy, and carrying forward the work after the death of its inceptor. Mr. Potts has taken out many patents on printing and automatic telegraph apparatus. The first decade of the century he devoted to the Rowland Telegraphic Company as electrical engineer, constructing engineer and chief engineer. He was afterward chief engineer of the Universal Telegraphic Company. Since 1915 he has been chief engineer of the Universal Machine Company of Baltimore, with offices in the Industrial Building. Mr. Potts is a native of Pennsylvania, born October 30, 1876, at Canonsburg. He graduated from Washington and Jefferson College, 1896, winning signal honors. He took the Ph.D. degree at Johns Hopkins University in 1900. He is a Fellow of the American Association for the Advancement of Science, a member of the American Physical Society and Société Française de Physique, and an associate member of the American Institute of Electrical Engineers — secretary since 1909 of the Baltimore section of that organization. Mr. Potts' home is at 2129 Maryland Avenue, Baltimore.

LOUIS M. POTTS

HENRY ST. CLAIR PUTNAM

HENRY ST. CLAIR PUTNAM

Henry St. Clair Putnam, who is one of the leading consulting engineers in the country, was originally intended for a legal career and practiced that profession for two years, when his inclinations, which were for engineering work, induced him to relinquish law. Mr. Putnam was born at Davenport, Iowa, July 8, 1861, the son of Charles Edwin and Mary Louisa (Duncan) Putnam. He received his preliminary education at the Davenport High School, from which he graduated in 1880. He then entered the State University of Iowa, and this institution conferred the LL.B. degree upon him in 1882. He practiced law for two years, and then entered the Rose Polytechnic Institute, Terre Haute, Indiana, to prepare for his engineering career. He graduated B.S. in 1886, and the institute conferred upon him the M.S. degree in 1905 and the M.E. in 1907. He became associated with the Engineering Department of the Thomson-Houston Company, where he remained during 1886 and 1887, and from 1887 until 1896 he was engaged in the manufacture of arc light carbons for the Thomson-Houston Carbon Company, the Brush Carbon Company and the American Carbon Company. Mr. Putnam began practice as a consulting electrical engineer in Chicago in 1896 and in 1900 transferred his activities to Philadelphia. In 1902 he came to New York as the partner of L. B. Stillwell, with offices at 100 Broadway. This firm has executed some very important work. It was in charge of the equipment of the Manhattan Elevated Railroad, the New York Interborough Transit Company (Subway), the New York Hudson and Manhattan Railroad and the New York, Westchester & Boston Railroad. He has also made many technical reports on various electric power projects. Mr. Putnam is a member of the American Institute of Electrical Engineers, the American Association for the Advancement of Science, the American Geographical Society, the Phi Delta Theta Fraternity, the Engineers', Railroad, Union League, City, and Lawyers' Clubs, of New York City; the Commercial Club, of Davenport, Iowa, and the Cosmos Club, of Washington, D. C. Mr. Putnam has been a close student of all things electrical, and his investigations have resulted in the contribution of many able articles to the technical press. Among the papers he has published are "The Electrification of Steam Railroads," "The Conservation of Power Resources," which was read at the White House Conservation Congress in 1908; "The Electric Propulsion of Canal Boats," "The Coasting Clock and the Economical Use of Power," and "The Economical Combination of Water and Steam Power Plants." Mr. Putnam resides at 118 East 54th Street.

GEORGE HERNDON PEGRAM

George Herndon Pegram, Chief Engineer of the Interborough Rapid Transit Company, the New York Railways Company and the Rapid Transit Subway Construction Company, was born at Council Bluffs, Iowa, December 29, 1855, and was graduated from Washington University, St. Louis, Mo., at the head of his class in 1877 with the degree of Civil Engineer. The degree of Master of Arts was conferred on him in 1905.

In 1898, the Manhattan Railway Company of New York City, contemplating the extensions of its lines, and the change of motive power from steam to electricity, appointed Mr. Pegram Chief Engineer.

His contribution, in a scientific way, was the suggestion of the twin compound engine with vertical low pressure and horizontal high pressure cylinders, operating on both ends of the generator shaft, as used in the 74th Street Power Station.

Mr. Pegram is a Member of the Railroad and the Engineers' Clubs in New York City, and a Past President of the American Society of Civil Engineers.

E. C. RANEY

It has doubtless been an important factor in the wonderful development of the electric industry on the engineering side that the greater electrical corporations have maintained experimental laboratories, with staffs of expert engineers constantly in counsel together, for the production of

E. C. RANEY

improved apparatus for the solution of engineering problems as they have arisen. And yet some of the best inventions for electrical betterment have been the product of individual effort working without these advantages of counsel and environment. An instance in point is the Automatic Reclosing Circuit Breaker, the first working model of which was made and tried out while its inventor, Mr. Raney, was still a student in the university.

Mr. E. C. Raney is a native of Fayette, Ohio, born August 18, 1882, and was educated at Ohio University, Athens, Ohio, and later took the Engineering Courses at Ohio State University, Columbus, Ohio, receiving the degree of M.S. in Electrical Engineering in 1912, and election to the honorary society of Eta Kappa Nu. In 1912 he was also instructor in electricity in the Columbus (Ohio) Trade School.

Meanwhile he had active experience in mechanical and engineering work, and in 1908 was in charge of a power plant of a coal company in Jefferson County, Ohio. While there, one of his assistants remarked to him that it seemed strange that there were circuit breakers which would open automatically in case of overload or short circuit, but none that would reclose when the short circuit had been removed. He argued that it was just as important to restore current to the line when the trouble was over as it was to break the current when the trouble occurred. He insisted that Mr. Raney should explain to him just why this defect could not be remedied, and it was while attempting to make this explanation that Mr. Raney discovered that it could be done.

In 1910 and 1911, while finishing his engineering courses at Ohio State University, Mr. Raney made the first working model of the Automatic Reclosing Circuit Breaker. The model was tested thoroughly on a branch circuit of a coal mine in Alabama in 1912. The potential of this circuit was 550 volts, direct current, and was subjected to very frequent "short." The model responded promptly and accurately to these tests, working so satisfactorily that Mr. Raney's friends urged him to organize a company for the manufacture of this apparatus on a commercial basis. In 1913 The Automatic Reclosing Circuit Breaker Company was organized for the manufacture of circuit breakers, relays, etc., and Mr. Raney has been general manager of that company ever since. The company began business upon a very modest scale, and only a few machines were built and put into operation during the first year of its business. But its merits soon met the recognition of the electrical world and the machine began to be adopted into use very widely, a gratifying growth of the business continuing from then each year to the present time. The reclosing feature of this circuit breaker is one of incalculable benefit because it makes immediately effective a renewal of service which was formerly only accomplished after long delay. It makes possible the automatic operation of hundreds of substations in the coal mining fields and in many railway stations.

THE BISHOP GUTTA PERCHA COMPANY

The Bishop Gutta Percha Company was the pioneer in the use of Gutta Percha as an insulator in this country, the founder of the business, Stephen D. Armstrong of Brooklyn, using the material seventy years ago. It was early in 1847 that Mr. Armstrong, who was at that time engaged in the manufacture of rubber goods, received his first consignment of gutta percha. He had been attracted by the reports of foreign governments and scientists on the adaptability of the new gum as an insulator for electric wires, and his own tests so pleased him that he went to England, where he secured the necessary machinery for the new process and four of the most valuable patents, with exclusive rights for their use in this country. The patents were at once filed in Washington and the machinery set up in Brooklyn the same year, 1847. In 1857 Mr. Armstrong sold his business to Samuel C. Bishop, who established a factory in New Jersey, removing in 1860 to East Twenty-fifth Street, New York, and fitting up the factory now owned and occupied by the Bishop Gutta Percha Company. W. W. Marks, a nephew of Mr. Armstrong, who was superintendent of the Bishop Gutta Percha Company for forty years, was connected with the Brooklyn factory when the machinery arrived from England. He helped equip the Twenty-fifth Street factory and had charge of it until his death in 1888. In the early stages gutta percha proved to be a failure as an insulator and Mr. Armstrong, founder of the business, was the first to successfully use wire insulated with gutta percha for working under water. This was a No. 9 wire, insulated to the diameter of half an inch, which was laid across the North River.

Upon the death of Samuel C. Bishop, Samuel Boardman, as executor of the estate, assumed control of the business, in which he had the assistance of his brother-in-law, Henry A. Reed, now president of the company, who was at that time engaged in expert accountancy. Mr. Reed's knowledge of electricity was of great value, and upon the organization of the Bishop Gutta Percha Company, in 1885, by the six legatees under Mr. Bishop's will, he was elected secretary. He was made manager in 1887; treasurer in 1893 and president in 1905. Upon the death of the legatees Mr. Reed bought the various interests until now it is entirely controlled by members of his family. He has as associates in the management his three sons—William Boardman, Henry Douglas and Louis F., who act respectively as treasurer, vice-president and secretary.

When the present company was organized in 1885 the business had fallen off considerably, but the infusion of new energy soon restored conditions to normal, and it was not long before the output of the company had largely increased and has grown steadily since that period. The Bishop Gutta Percha Company aims to make the best, not the cheapest goods, and in almost every case where the product of the company has been in competition with that of other manufacturers, the standard quality of the Bishop company's goods has won although the price set was higher than that of other bidders. Since Mr. Reed's connection with the company, the process of manufacture has been entirely changed and the value of its use for insulation successfully demonstrated. This was in a large measure due to Mr. Reed's inventive ability, as he evolved methods that turned early failure into success. In all the developments of the various electrical industries, the company has kept pace with the varied demands for conductors of every description and many of the wires and cables used by the telegraph, telephone, electric light and electric railways have been made by the company. Many of the cables used by the Light House Board, the Life Saving Service, the Army Signal Service and Weather Bureau, were also planned and produced by the company. In addition to cables, the Bishop Gutta Percha Company manufacture a full line of gutta percha goods, among which is gum tissue, largely used in surgical work, by hat manufacturers, for ladies' dress shields and a hundred other purposes. The factory of the company, 420 to 430 East 25th Street, being inadequate for the steadily growing business, the building 403 to 407 East Twenty-third Street was acquired and the most modern machinery installed for the manufacture of the gutta percha specialties.

HENRY A. REED

HENRY A. REED

Henry A. Reed, president of the Bishop Gutta Percha Company, has during his long and active career done much valuable work in matters relating to the manufacture of submarine cables and other insulated electrical wires and has on many occasions been consulted as the best authority on such work by government departmental heads, among whom were General A. W. Greely, U. S. Signal Corps and Admiral W. S. Schley, of the Light House Department. Mr. Reed was born at Carmel, Putnam County, New York, February 11, 1829, and is a descendant of John Reed, an officer in Cromwell's Army, who came to America from Cornwall, England, in 1660. At the age of seventeen he began teaching in the Carmel district school and when twenty, while still teaching, he learned telegraphy and was placed in charge of the Carmel telegraph office, July 1, 1849. One year later he opened a telegraph office at Croton Falls, the first on the Harlem Railroad, and was on July 1, 1850, transferred to Hudson, where he remained two years and witnessed the first railroad train that ran from New York to Albany on the Hudson River Railroad. In 1852 he was appointed operator in the New York office of the New York, Albany & Buffalo Telegraph Company, at which time three operators took care of all the New York telegraph business over these lines to the North and West. In 1853, Mr. Reed was placed in charge of the Poughkeepsie office of this company. The telegraph business did not take up his entire time, so he opened a bookstore in 1855, into which he removed the telegraph office and managed both. While engaged as an operator Mr. Reed was the first man to attempt to locate wire trouble at points distant from his office, by measuring the currents with his lips and fingers. On one occasion he accurately located a "break" twelve miles distant, where lightning had struck a pole and broken the wire. Professor S. F. B. Morse was a resident of Poughkeepsie at this time and an intimate friend of Mr. Reed, frequently visiting his office. In 1855, he was present when Mr. Reed was using his primitive method of locating trouble and suggested that he had an instrument that he thought would be more accurate for the work. He thereupon presented him with a small galvanometer, the first to be used for this purpose in America. This instrument is now in the Smithsonian Institute in Washington, D. C. At the outbreak of the Civil War, when Mr. Reed was receiving the news of the firing on Fort Sumter, Commodore afterwards Admiral Farragut was standing by his side, and when told of the startling event said: "That means I must go to Norfolk at once. I have many friends there, but if duty requires, I will blow the city to H—l." In 1866, Mr. Reed gave up telegraphy to devote his entire time to his book business, which had grown to large proportions. In 1876, he sold the store, shortly afterwards taking up expert accounting. He came to New York in 1878 and assisted in the management of the estate of Mrs. Samuel C. Bishop, which was operating the Bishop Gutta Percha Works, and which was threatened with a lawsuit for infringement of the Simpson patent, covering the use of gutta percha as insulation. A similar action had been brought successfully against the Western Union Telegraph Company, but the data collected and prepared by Mr. Reed caused the plaintiffs to withdraw their suit against the Bishop Company. In 1885 he was made secretary of the Bishop Gutta Percha Company by the legatees of Mrs. Bishop, and in 1887, became General Manager and at once bent his energies to build up the business, which was rapidly decreasing. Mr. Reed has always taken an interest in electrical affairs and keeps well posted on the development of the industry. He foresaw that rubber would be a much better insulator for any conductors that were to be used anywhere except under water and at once engaged an experienced engineer to design and install machinery to insulate wire and cables with rubber. In 1887, Mr. Reed was called in consultation by the U. S. Light House Board, which was engaged in devising a system for lighting river channels by lighted buoys and range

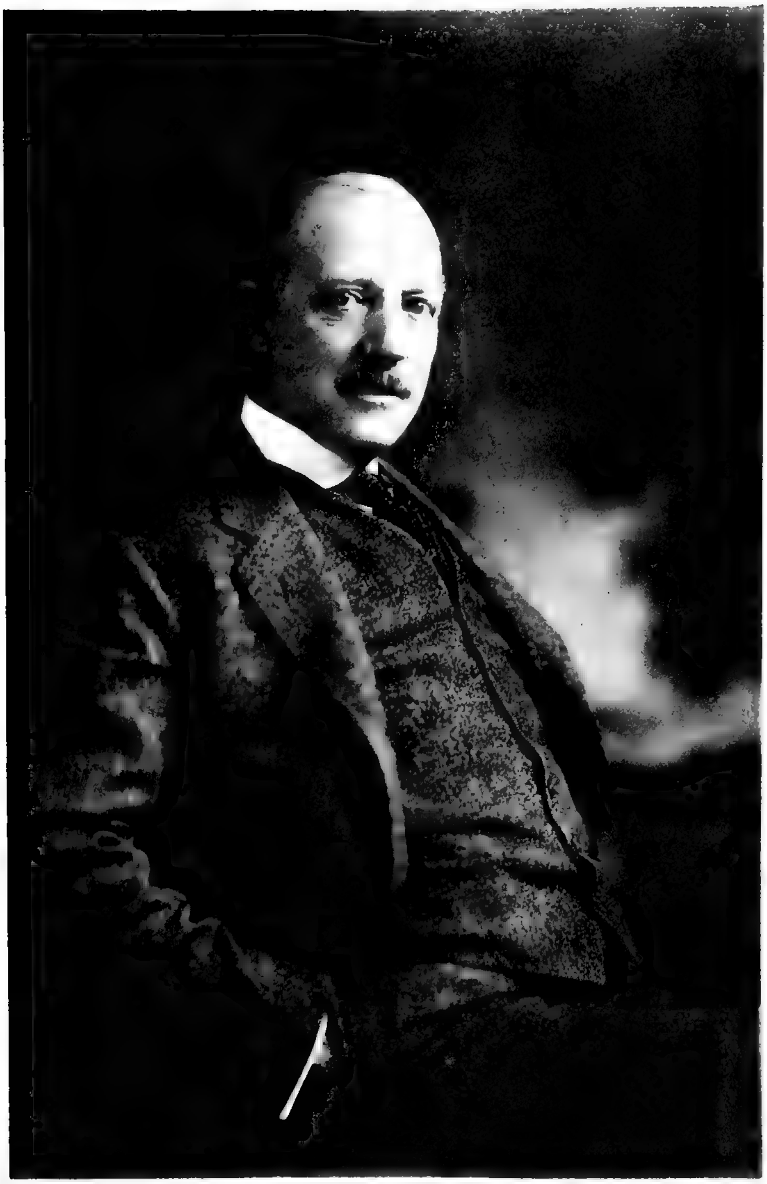
lights. In 1888, he designed and furnished the first high tension cables to be used underground. In 1905, Mr. Reed became president of the Bishop Gutta Percha Company.

Mr. Reed was one of the organizers of the Electric Club and the Electric Trade Society, serving on the Executive Committee of the latter and being its president for one term. He was on the House Committee of the Electric Club and exhibited at one of the meetings of the club the first perfected phonograph made by Mr. Edison. Mr. Reed is a member of the American Institute of the Electrical Engineers. He was married May 14, 1859, to Alice Amelia Boardman, sister of Andrew and Samuel Boardman of the well-known law firm of Boardman & Boardman of New York. The union brought three sons, William Boardman, Henry Douglas and Louis Francis Reed and one daughter, Alice Augusta, now Mrs. Richard Deeves. Mr. and Mrs. Reed reside at 88 North Ninth Street, Roseville, Newark, N. J. On May 14, 1909, they celebrated their golden wedding, on which occasion two of the bridesmaids at their wedding in 1859, were present. Many handsome presents were received by the couple from the children, the factory employees, business associates of Mr. Reed and members of the Presbyterian Church of which they are members.

HENRY DOUGLAS REED

Henry D. Reed, Vice-President of the Bishop Gutta Percha Company, was born in Poughkeepsie, New York, February 11, 1869, the son of Henry A. Reed and Alice A. (Boardman) Reed. The family moved to New Jersey, November 2d, 1880, and Mr. Reed successively attended the district school in Scotch Plains, the grammar school in Bergen Point and the Newark High School. During his second year at the latter institution he won the Hammer prize for making the best set of apparatus for demonstrating the elementary principles of electricity and physics. The set consisted of twenty-four pieces of apparatus. After finishing his studies at the high school, Mr. Reed entered Stevens Institute of Technology and graduated in 1892, with the degree of M.E., and immediately afterwards entered the employ of the Bishop Gutta Percha Company. His first work with this concern was the careful study of the machines in each department with the view of improving the product and increasing the output, in which work his technical training was a great aid and of inestimable value to the company. He then took up the electrical part of the work and continued in this line until 1900, when he devoted more time to assisting in the management of the rapidly growing business. In 1906 he was elected vice-president, a position he still holds. Mr. Reed has been with the Bishop Gutta Percha Co. over twenty-six years and is well known in the insulated wire industry. He is a member of the American Institute of Electrical Engineers, the Engineers Club, the New York Electrical Society, Stevens Alumni Association, the Essex County Country Club, the Glenwood Tennis Club and the Roseville Athletic Association. He was married December 15, 1904, to Emilie R. Currier, of Newark, N. J. He now resides in East Orange, N. J., and is one of the Water Commissioners of that city.

HENRY D. REED



WM. BOARDMAN REED

WILLIAM BOARDMAN REED

W. Boardman Reed, who retired from practice as a civil engineer to accept the position of treasurer of the Bishop Gutta Percha Company, of which his father and brothers are also officials, was born in Poughkeepsie, New York, May 27, 1860. He was educated in the Poughkeepsie Preparatory School, afterwards entering Union College, graduating in 1882, with the degrees of A.B. and C.E. He immediately began the practice of his profession, and from 1882 until 1890 was civil and mining engineer at Lake Champlain Mines, New York. In 1891 he had charge of the construction of the water supply for Northville, N. Y., and from 1892 until 1894 was chief engineer of the Cayadutta Electric Railway, constructing the line from Fonda to Gloversville. From 1894 until 1906 he was engineer of Maintenance of Way of the Metropolitan Street Railway of New York City and while in this position invented, but did not patent, several appliances, which have since come into general use in all the large cities of the country. In 1889 he made an inspection and report on the magnetite ores of the Island of Cuba and during his active practice as an engineer made a reputation as a specialist in railway track construction and maintenance. He was president of the Otsego and Herkimer Railroad Company from 1909 until 1914. He relinquished his professional work in 1906 to accept his present position. Mr. Reed is a member of the American Society of Civil Engineers, Engineers' Club, New York Railroad Club, Delta Phi Fraternity, graduate Council of Union College. Has resided since 1906 at Mt. Vernon, N. Y.

WILLIAM BIRCH RANKINE

(Deceased)

The electrical development of Niagara Falls, the world's most striking exhibit of electrical progress, owes much of its successful accomplishments to the late William Birch Rankine, whose firm faith, purposeful initiative and convincing personality overrode obstacles and brought into effective organization and successful operation The Niagara Falls Power Company project.

He was born in Owego, N. Y., January 4, 1858, the son of Rev. James Rankine, D.D., LL.D., distinguished divine and educator, sometime President of Hobart College and Rector of the Delancey Divinity School at Geneva, N. Y. Mr. Rankine was educated at the Canandaigua (N. Y.) Academy, entered Hobart College in 1873 and later went to Union College, Schenectady, from which he was graduated A.B. in 1877, with election to the Phi Beta Kappa, and later received the A.M. degree.

For three years following his graduation he lived and studied law at Niagara Falls, and was admitted to the bar in 1880. While engaged as a law student he became deeply impressed with the problem of Niagara's power and its successful utilization for the purposes of industry. Following admission to the bar, he went to New York City in 1880, and engaged in general practice of law there until 1890. During that period he became actively identified with the preliminary stages of organization of The Niagara Falls Power Company, carrying through the fight for procurement of State Charter and municipal privileges, the work of procuring lands at fair values, of allaying popular apprehension that economic exploitation would mar the beauty of the cataract, and the formidable industrial obstacles placed in the path of the enterprise. He was the first secretary of the company and later its vice-president, and from 1890 he devoted his entire attention to company's affairs. He interested great capitalists, such as J. Pierpont Morgan, D. O. Mills, Morris K. Jesup, John Jacob Astor, W. K. Vanderbilt and many others, in carrying the enterprise to strong and successful organization.

Besides this financial backing was that of the world's most famous electricians, including Lord Kelvin, Thomas A. Edison, Nikola Tesla and others of world-wide fame, all of whom were made the personal friends and became the enthusiastic admirers of Mr. Rankine.

He removed to Niagara Falls perma-

WILLIAM BIRCH RANKINE

nently in 1899, and became its foremost citizen. He was well known and popular on the Canadian side also, had secured a charter for the Canadian Niagara Power Company, of which he was vice-president, besides being second vice-president and treasurer of the Niagara Falls Power Company, the Niagara Junction Railway Company and the Niagara Development Company, and stockholder, director and officer in numerous corporations and clubs. He was prominent in the Episcopal Church, Chancellor of the diocese of Western New York, member of the Standing Committee, deputy of the Episcopal Fund. He died September 30, 1905, deeply lamented, but leaving a great and finished work.

HENRY GERBER REIST

The work of those specialists in electrical and mechanical engineering whose efforts have been largely concentrated upon improvements in generator design has been an important factor in the progress of the electrical industries. Among these experts Henry Gerber Reist, of the General Electric Company, is prominent.

He was born at Mount Joy, Pa., May 27, 1862, and is of Swiss descent; his first American ancestor having come to this country in 1724 and purchased a farm near Mannheim, Pa., still held in the Reist family. He was reared on a farm and educated in country schools, high school and State Normal School, later taking the mechanical engineering course in Lehigh University, from which he was graduated with the degree of M.E. in 1886. He also received election to Tau Beta Pi,

honor society; became a member of the Phi Gamma Delta Fraternity, and was captain of the college tug-of-war team for three years.

He was in the foundry and machine department of the Harrisburg (Penn.) Car Company from 1886 until 1889, being assistant superintendent of that department when he left it. A general interest in electrical machinery, and a belief that this line of work promised rapid development, led him to connect himself with the Thomson-Houston Electric Company in 1889, and he has served ever since with that company and its successor, the General Electric Company. He has had charge of the design and construction of rotating alternating current machinery for the General Electric Company since 1894. During this time the generators of this class have increased in size from a few hundred kilowatts to 50,000 k.v.a. About seventy-five patents have been taken out on Mr. Reist's inventions.

He has given special attention to the mechanical development of electrical machinery. His designs are known for their good lines and harmonious appearance as well as for their safety and economical use of materials. He has done much work toward solving the problem of cooling electrical machinery, having had granted to him a fundamental patent for the systematic ventilation of laminated cores by means of space blocks, now universally used. The closed slot, generally employed in Europe, is not favored by American engineers, who are enabled, by using open slots, to insulate coils completely before placing them in a machine, thus facilitating repairs besides securing better insulated coils. The "barrel" type of coil, now in general use in America, permits a ready crossing of the strands composing a large conductor, thus greatly reducing the so-called "load losses." The reduction of these losses has long been a specialty with Mr. Reist. Another prominent advantage of American over European practice is the use of enamel, instead of tissue paper, as plate insulation, preventing the loosening of the core during operation, with the attendant dangers to coil insulation and lessened conductivity of heat in a direction transverse to the face of the punchings. American design and construction allows cores to be so built up that practically no filing is needed in winding slots or airgap face; and eddy losses at those points are prevented. To these American improvements Mr. Reist has been a foremost contributor.

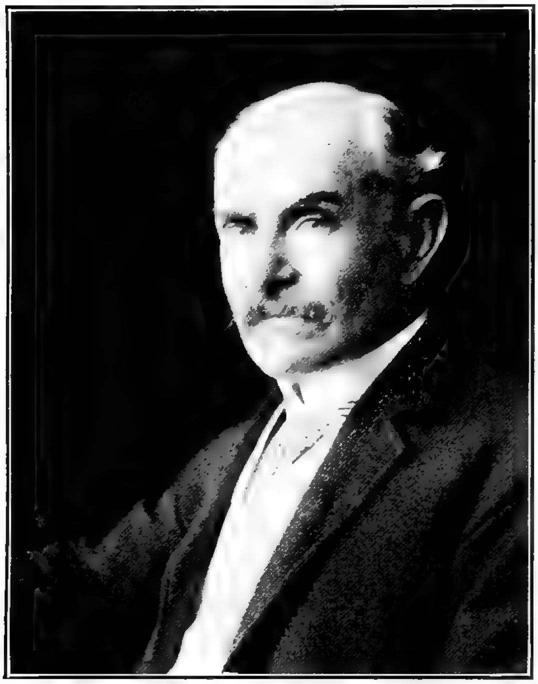
He has recently made important progress in the design of thrust bearings for supporting the weight of the rotating parts of vertical shaft generators. The feature of the design is to distribute the load by the use of supporting springs, preventing any part from being overloaded. This allows the use of increased bearing pressures and greatly reduces the bearing losses. The same principle has been applied to journal bearings.

He is a fellow of the American Institute of Electrical Engineers, member and past vice-president of the American Society of Mechanical Engineers, member of the American Electrochemical Society, American Association for the Advancement of Science, member and past president of the Society of Engineers of Eastern New York, and of the Schenectady County Historical Society, member of the Mohawk Club and Mohawk Golf Club.

LEONARD F. REQUA

Leonard F. Requa, president of the Requa Motor Co., was born in New Baltimore, Greene County, N. Y., May 12, 1844, of Huguenot ancestry, his grandfather, Joseph Requa, the founder of the American branch of the family, serving as an officer in the Continental Army during the Revolutionary War, and being wounded at the battle of Saratoga and also at White Plains. Mr. Requa was educated at Coeyman's Landing, Albany County, N. Y., and was engaged in commercial pursuits before entering the electrical line. Following the great sleet storm of 1886, when practically all telephone, telegraph and electric wires were prostrated, there was a demand for an insulation that would stand underground work, and this led Mr. Requa to investigate the problem. After long experiment he suc-

ceeded in making a seamless rubber-covered insulation, which worked perfectly underground and met the approval of many of the electric companies. He organized the Safety Insulated Wire and Cable Company, in March, 1888, for the purpose of manufacturing his invention, and the first order

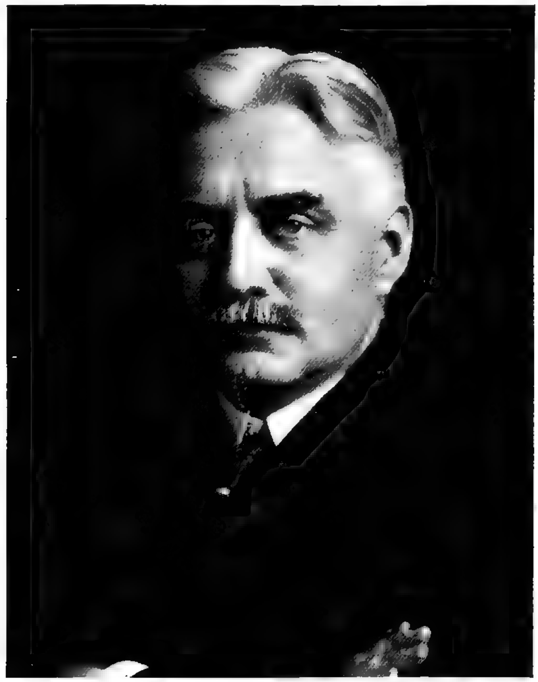


LEONARD F. REQUA

was given the company by William H. Eckert of the Metropolitan Telephone Company. This was for five miles of No. 18 B. & S. gauge, and was supplemented three days later by an order for fifty miles. The electric light cable for underground use was first submitted to John D. Crimmins, who referred the matter to Edward A. Leslie, the manager of the Manhattan Electric Light Company, who gave an order for one mile for test purposes, and a few days later purchased fifty miles. The East River, the Mt. Morris and other lighting companies adopted the cable, and the factory was taxed to install machinery fast enough to keep up with the demand. Mr. Requa sold his interest in the company in 1902, since which time he has been engaged in other branches of industry.

DAVID BARKER RUSHMORE

Following in the footsteps of his progenitors, who were inventors and engineers, David Barker Rushmore has risen to prominence in his profession. He was born August 21, 1873, in Old Westbury, Nassau County, New York, the son of John



DAVID B. RUSHMORE

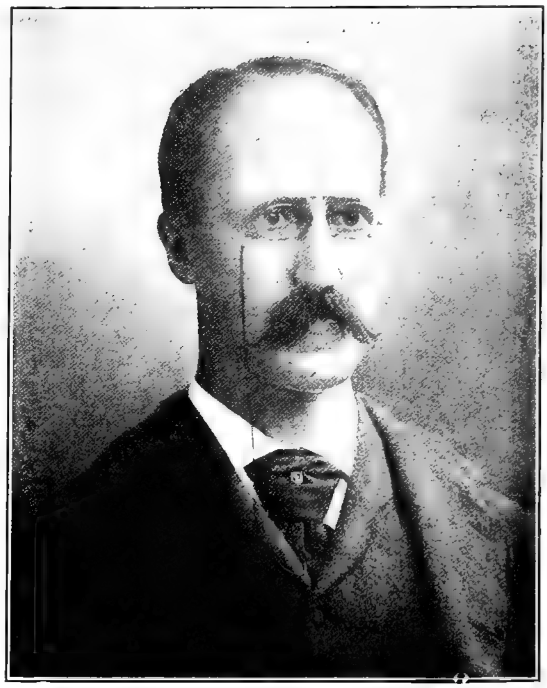
Howard and Julia Anna (Barker) Rushmore, and was educated at the Swarthmore Preparatory School, Swarthmore College and Cornell University. He graduated from Swarthmore with the B.S. degree in engineering in 1894 and received the C.E. degree in 1897. From Cornell University he received the M.E. degree upon graduation in 1895. In 1894, he was employed by the Westinghouse Electric Manufacturing Co. at the Newark, N. J., plant and in 1895 was with the same company at the East Pittsburgh factory. In 1896, he was foreman of the testing department of the Royal Electric Works, Montreal, Canada. In 1899 he became Transmission and Designing Engineer for the Stanley Electric Manufacturing Company and in 1906 he was appointed engineer of the Power and Mining Department of the General Electric Company, Schenec-

tady, N. Y., a position he still fills. He is a life member of the American Society of Civil Engineers and the American Institute of Mining Engineers, and the New York Electrical Society, a past manager and vice-president of the American Institute of Electrical Engineers, a member of the National Electric Light Association, Association of Iron and Steel Electrical Engineers, American Society of Mechanical Engineers, American Electrochemical Society, American Iron and Steel Institute, American Association for the advancement of Science, Engineers' Club of New York, New York Athletic Club, Bankers Club of America, Institution of Electrical Engineers, Great Britain, Société Internationale des Electriciens, France, the local clubs of Schenectady, New York, and the Delta Upsilon Fraternity.

HENRY AUGUSTUS ROWLAND

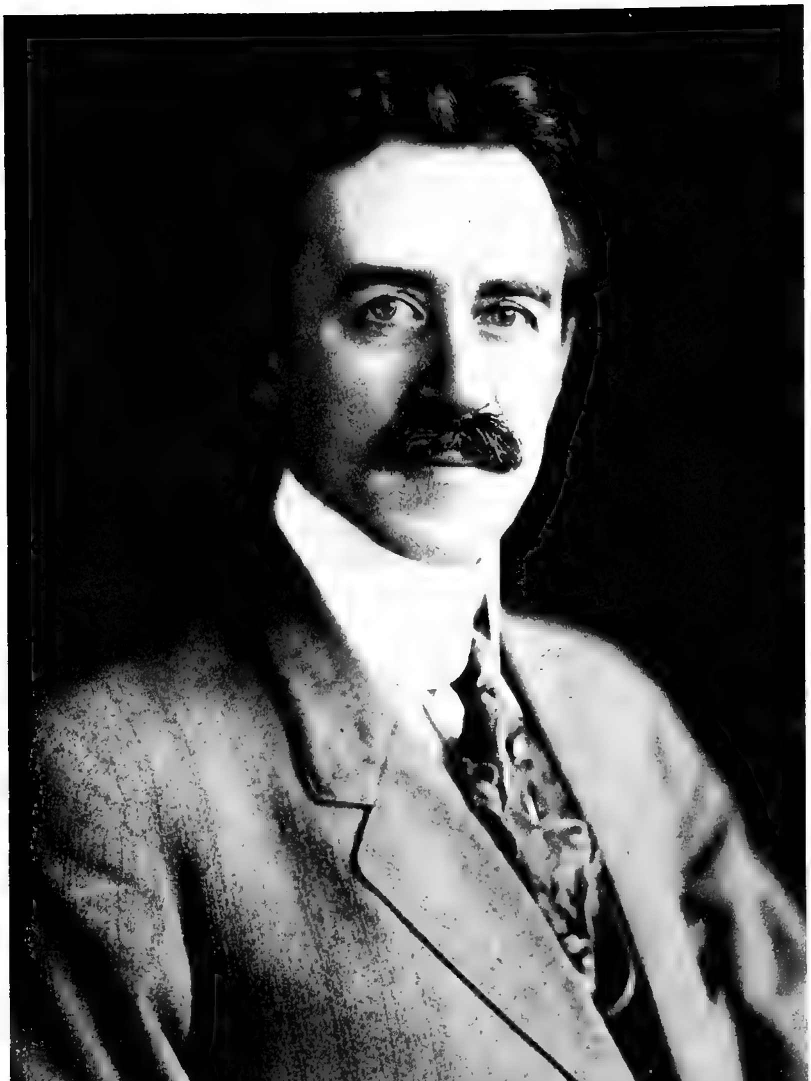
The memory of Henry A. Rowland is one cherished by his contemporaries and revered by the whole scientific world. He stood high in a small group of international and pre-eminent scientists who during that fertile period of discovery, the last quarter of the nineteenth century, penetrated to the secrets of fundamental laws, bringing many into light. Just prior to his appointment in 1875 to the professorship of physics in the Johns Hopkins University, he anticipated all subsequent investigations in the announcement of the simple law of the magnetic circuit. Later he made a profound impression in Berlin, by reason of the results obtained from important studies of the magnetic effect of moving electrostatic charges.

When he turned his investigating zeal to the study of light, it was to meet baffling obstacles. Although the solar spectrum was recognized as the key to problems in ether physics, the medium through which it was produced and studied proved an obstacle to successful experiments. Robert Boyle, more than two hundred years ago, Fraunhofer and Nobert, made various types of fine ruled gratings for measuring the length of light waves. Lewis M. Rutherford, an amateur astronomer of New York, later constructed a machine that produced gratings superior to those of Europe, but it fell short of the fine degree of mathematical precision required. Rowland's mechanical genius here came into play. He attempted the correction of a vital defect after a vast amount of thought had been expended upon it and achieved a result of astonishing perfection. Perfecting the machinery for making ruled gratings was to him, however, a step to a greater discovery. The concave grating immediately simplified the processes involved in the use of the diffraction spectroscope. In Rowland's laboratories came that development of scientific photography which re-



HENRY A. ROWLAND
(Deceased)

sulted in the "Photographic Map of the Normal Solar Spectrum," now recognized as a world standard. As an engineer his counsel was followed in some of the most important projects of the century. Even a partial chronicle of Rowland's contributions to scientific effort would necessitate a voluminous story of never ceasing activity. In number of titles his writings were exceeded by many of his



HAROLD ROWNTREE

contemporaries, but their quality placed them at the forefront of scientific thought. As a youth, born in Honesdale, Pa., Nov. 27, 1848, his mind was early set upon his destined career, for he went first to Rensselaer Polytechnic Institute, Troy, N. Y., graduating in 1870. A biographical memoir by Thomas C. Mendenhall, read before the National Academy of Sciences in 1903, ably covers the salient characteristics of the man and the scientist. Henry A. Rowland died April 16, 1901, and in the fullness of his powers. It was his good fortune to receive universal recognition during life; first, in the bestowal upon him of degrees by higher institutions of learning and election to membership in nearly all scientific societies worthy of note in Europe and America; second, in the more significant honor of wielding a potent and beneficent influence upon the whole realm of science.

HAROLD ROWNTREE

One of the prime promoters of progress in the solving of the mechanical problems incident to the practical operation and improvement of modern electrical devices, is Harold Rowntree, of Kenilworth, Ill., president of the National Pneumatic Company; president of the Burdett-Rowntree Manufacturing Company, and vice-president of the Elevator Supplies Company. The United States Patent Office records in the neighborhood of one hundred of his patents, covering inventions through which have come radical improvements in one of the most universally used of all mechanical systems, the rapid transit facilities depended upon by myriad New Yorkers and the populations of all our great cities. When in the subway rush hour the apparently hopeless congestion is dissolved, and we with the countless throng are sped on our way in time measured by seconds; when the high speed elevator soars from street to dizzy height in the office building, discharging us at the exact level of our floor so accurately and smoothly as not even to disturb our thoughts; we are in contact with more convincing evidence of the inventor's accomplishment than any quantity of government statistics. Although Mr. Rowntree disclaims a natural liking for mechanics and bases his aptitude in invention upon a predilection for mathematics, this matter of taste seems to have had no deterring effect upon either the prolificness or utility of the product. A major portion of his attention is centered in the study of automatic control of electrical devices. He was the first to provide means for automatically slowing down the speed of electric elevators before stopping, and the first to apply this slowing down process to those automatic elevators and dumbwaiters that have pre-determined stopping points. Illustrating the frequent embarrassments, delays and frustrations to which many an inventor is subject, is the case of an improvement in elevator operation waiting some twelve years for general recognition. Originally Mr. Rowntree patented a double electric motor equipment for elevators which enabled the cars to be operated at a high rate of speed, and yet stopped accurately level with the floor. The first complete test occurred when a dumbwaiter embodying the invention was constructed and installed in a twelve-story building. It fulfilled expectations to the fullest degree, running at a speed of eleven hundred feet per minute, yet being so absolutely under control that the car could be stopped automatically at any floor without varying the part of an inch from the correct level. The car was operated successfully for years before its adoption elsewhere, for when first introduced it was too speedy for the prevailing gait of business, and consequently met no demand, or rather exceeded it, as its inventor had anticipated the time. Eventually the strides of commerce caught up with the idea. The day arrived when Uncle Sam straining every nerve in the colossal tasks of the war program, gathered in the dormant energies of neglected utilities and made them work. The Government ordered immediately, and put into use, a large number of heavy automatic freight elevators designed for such speed of operation and accuracy of stops as necessitated the utilization of the type of

double electric motor equipment described.

Mr. Rowntree was the first to invent a means for the pneumatic operation of doors on elevated and subway trains, and he provided for electrically controlling such devices. He led in the invention of interlocking electrical connections. Thus the safety of the passengers was secured by the train not being able to move while any doors were open, nor the doors capable of opening while the train was in motion. Another source of danger was removed by the automatic arresting of the doors when by chance a passenger might be struck by its closing. He has recently invented and patented electric means for automatically limiting the speed of a train by the combination of the speed of the train ahead and the distance of the train ahead. It is estimated that the use of this invention on congested subway systems would at least double their passenger carrying capacity per hour without in any way increasing the possibility of accidents.

Further successful experiments dealing with the automatic control of automatic mechanism, brought forth a recently patented invention of unlimited scope of application. Its practical employment might all but revolutionize the conduct of our telephone and telegraph systems to say nothing of the effect upon elevator management and divers other agencies of modern intercourse. At least the efficiency of dispatch would be doubled if this device be accepted and applied to the innumerable machines and apparatus controlled by electric currents and responding to them in a fixed manner of correspondence. The device allows of automatically recording all calls requiring circuit connections, storing them up and automatically forwarding them to the controlled apparatus as soon as it is released from previous service. For example, calls for an automatic dumbwaiter or elevator which is already in use or is not in condition to respond to the call and until it is ready to respond or has completed the service in which it is ready to respond or has completed the service in which it was engaged; and then such call will be automatically forwarded to the machine as soon as it is at liberty to respond. A still greater field of usefulness is susceptible to the benefits of this invention in telegraphy and telephony. Instead of the incalculable delays following upon "line's busy" and a harassed and forgetful central, our telephone calls may be amazingly expedited by eliminating the human element while the calls are automatically recorded and retained until the desired connections are in condition to receive them when, again automatically, they will be forwarded. In like manner, business men would find that a vastly increased dependence might be placed upon the expeditious transmission of their telegraphic business were the same improvement adopted by the telegraph systems. Especially would it prove invaluable where, under present conditions, long distance messages must be relayed from one line to another at intermediate points. There would be an obvious saving of time by the automatic relaying of messages. The automatic control obtained by this device insures the receiving, recording and retaining of all messages and their prompt forwarding at intermediate points when lines become available, providing also for the forwarding of messages in the exact order in which they are received.

The Rowntrees are an English family whose genealogical records go far back into English history. Harold Rowntree began life in Bradford, England, on October 5, 1865, and was educated there in private schools, from whence he went to learn and later engage in the machine trade. His ancestors had had the name of having unusual qualities of pertinacity and perseverance in their undertakings, a trait easily confused with obstinacy. It was, though, an obstinate, not-to-be denied aim that governed young Rowntree's professional progress. He had ideas in those days reaching far beyond his environment, vital, if youthfully immature, and portentous of rapid future development. Throughout the domain of scientific exploration the phenomena has been noted of the simultaneous awakening of advanced minds to a new set of facts as if their thoughts were in some manner synchronized. Many years before we were thrilled by the first hazardous flights of the aeroplane, the problem of overcoming the air was insistently knocking at the doors of science. Very few gave it serious consideration. But Mr.

Rowntree in one of his early note books filled with speculative solutions, went so far as to describe, boyishly 'tis true, but none the less accurately, the future monoplane, having wings four feet wide and forty feet from tip to tip, and the body about the size of those in use today; but he, like others, was nonplussed by the question of motive power. In defining invention, as Mr. Rowntree says, one must realize the interdependence of inventions and the fact that they invariably follow a regular sequence of evolutionary growth, resulting often in an invention being ahead of its time and necessitating the making of several inventions in order to reach one practicable. He is a man of markedly studious habits, delighting to delve into fundamental laws and untiringly searching for fresh conclusions.

Mr. Rowntree's career in America dates from 1884. Undoubtedly he found the upbuilding, progressive American spirit a stimulation because, a few years later, in 1890, he commenced the series of inventions which have brought him high name and reputation. He is a member of several electrical engineering clubs and societies. His offices, with the National Pneumatic Company, are at 50 Church Street, New York.

R. SANFORD RILEY

One of the fundamental reasons why the central electric stations of the United States are able to supply electric current at the wonderfully low prices they do is that the great majority of them are equipped with mechanical stokers, which add in a marked degree to the efficiency of the plants. The subject of this sketch, R. Sanford Riley, of Worcester, Mass., is a leader in the development of the mechanical stoker and is devoting his life to its improvement and exploitation, especially in the electrical industry.

R. Sanford Riley was born in Canada in 1874 and spent his boyhood in the City of Winnipeg. Both his father and his mother are descended from a line of old Yorkshire (England) stock, and his great-grandfather was an English officer in the Napoleonic wars. His father is a prominent banker of Winnipeg, Canada. Mr. Riley graduated with honors in 1896 from the Worcester Polytechnic Institute. In college he was president of his class, editor of the class book, played center on the football team and is a member of Sigma Alpha Epsilon Fraternity. He is president of the Worcester Chamber of Commerce, vice-president of the Worcester Y.M.C.A., and a member of the American Society of Mechanical Engineers, Engineers' Club of New York, Engineers' Club of Boston, Worcester Club, the Tatnuck Country Club, The Detroit Athletic Club, The Appalachian Club and the Alpine Club of America. Mr. Riley has climbed some of the highest mountains in Switzerland and the Canadian Rockies. He is very fond of horses and keeps a hunter for his own riding. He is a former member of the American Institute of Naval Architects and Marine Engineers, and holds the highest certificate of competency issued by the British Board of Trade—that of Extra First Class Engineer. He also holds the highest U. S. certificate as Chief Engineer for unlimited tonnage on any ocean.

Between 1898 and 1903 Mr. Riley worked his way around the world as a Marine Engineer. He started from Cramp's shipyard in a ship which, as a draftsman, he had helped to design. He sailed the Pacific in the Empress Line and joined the United States Navy in Hong Kong. He went through the Boxer campaign and came home via the Indian Ocean and Suez Canal as Chief Engineer of the "Arethusa," a naval auxiliary used as a base ship for torpedo boats. On the Asiatic Station Mr. Riley assisted in manoeuvers under Gen. Funston for the capture of

Aguinaldo. He left the sea to enter the employ of the N. Y. Ship Building Co. of Camden, N. J.

In 1906 Mr. Riley became manager of the American Ship Windlass Co. of Providence, R. I., and here he had an opportunity to put his naval engineering experience to further use in the design of windlasses and steering engines. But he soon specialized on the "Taylor" stoker, then being manufactured by the American Ship Windlass Co. in crude form as it had been left at the death of the inventor. He thus became known as a pioneer in the commercial development of high capacity under-feed stokers, which have revolutionized modern boiler rooms. Having been around fire rooms, ashore and afloat, all his life, Mr. Riley knew something of combustion. The fire room evidently had been neglected and had not shared the progress made in the engine room. Mr. Riley proceeded to redesign and improve the "Taylor" stoker and built up a large business.

In 1911 Mr. Riley sold out his interest in the American Ship Windlass Co. and later organized the Sanford Riley Stoker Co., Ltd., of Worcester, Mass., to develop and market the Riley Self Dumping Underfeed Stoker. By its use the capacity of many old boiler rooms has been tripled and in some new plants, like the Buffalo General Electric Co., the Riley stoker gives 500% of their normal boiler output, a capacity which would have been deemed impossible a few years ago. The stokers developed by Mr. Riley have changed the dirty boiler room from the most undesirable part of the plant into a place which now attracts brains and not brawn. In the modern boiler room the stoker handles coal and ashes automatically, and obtains the maximum number of heat units from the coal, with the result that boiler room labor is cut to a minimum, one fireman and one water tender being able to handle as high as 10,000 boiler H.P. Mr. Riley has to his credit a number of inventions in marine machinery and boiler room equipment, especially stokers. He is also President of the Murphy Iron Works of Detroit, the oldest and perhaps the largest manufacturers of stokers exclusively in the country. This Company was founded in 1878, and its product is primarily adapted for the smaller industrial concerns rather than the large public utility plants for which the Riley Stoker is particularly suited.

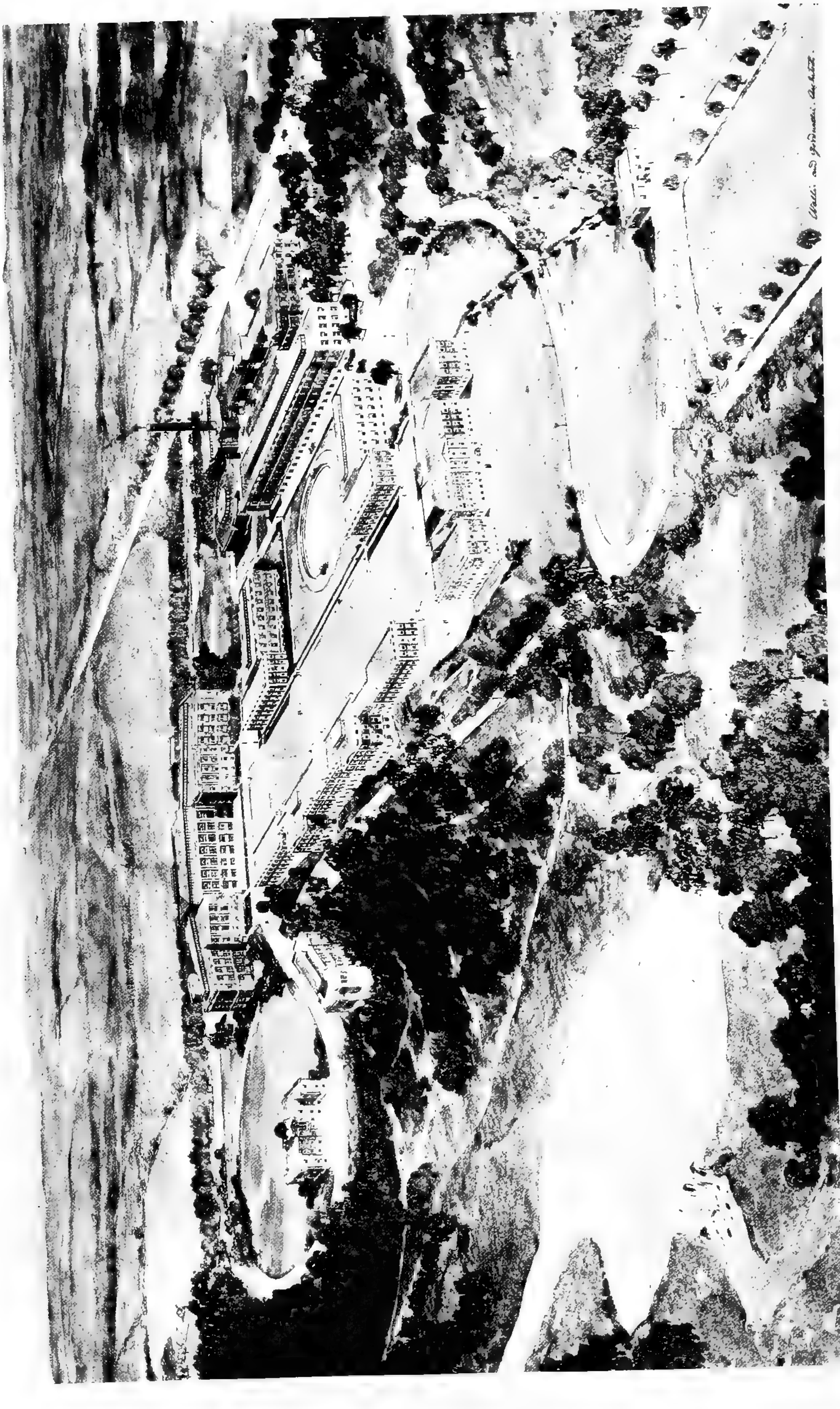
D. FREDERICK SCHICK

The prominence in the electrical engineering profession which D. Frederick Schick has attained, has not come by an easy road. Born in Philadelphia in 1875, he received his general education in the George Meade Grammar School, and at the old Eastburn Academy, from which he was graduated. He was then employed by the West End Electric Company for two years as wireman, oiler, and switchboard and dynamo tender. In this connection he realized the fact that without technical education it was practically impossible to reach any success of importance in the electrical field. Therefore, he entered the mechanical arts course of the Drexel Institute. While pursuing the studies in the institution, he spent his summer vacations in the employ of the Complete Electrical Construction Company, New York City, in installations of electric light systems. After graduation from the Mechanical Arts Course, Mr. Schick returned to the Drexel Institute for a two years' course in electrical engineering, and when he had completed it became construction foreman with the firm of J. F. Buchanan & Co., electrical contractors, of Philadelphia. He left this firm in 1899 to work for the Philadelphia Electric Company, being employed as a wireman in the construction department, starting work at the old Callowhill Station at Twenty-sixth and Callowhill Streets. By successive promotions he became foreman, draftsman, office assistant and finally succeeded James T. Hutchings as Superintendent of Distribution and Construction for the company. That title was

D. FREDERICK SCHICK

dropped, however, in May, 1916, because the department covered all of the electrical design, as well as the distribution and construction, and Mr. Schick became known as "electrical engineer" for the company. His place as a leader in the electrical engineering profession had been won by hard work, continuously followed up by intense enthusiasm for his profession.

Mr. Schick is a Fellow of the American Institute of Electrical Engineers, and a member of the National Electric Light Association, and has for several years been a member of the Electrical Apparatus Committee of that Association. He is also a member of the Illuminating Engineering Society and of the Engineers Club of Philadelphia.



NELA PARK, CLEVELAND.

Mention of which is made many times within this Volume. It appears more like some Great University than the Manufacturing Establishment which it is, and well Illustrates how Attractive the usual Grimy Factory may be made

JOHN MARTIN SCHREIBER

JOHN MARTIN SCHREIBER

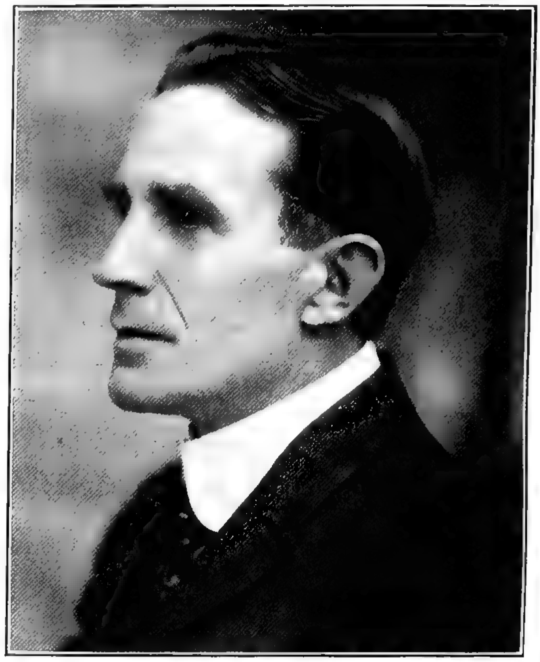
John Martin Schreiber, Chief Engineer of the Public Service Railway Company, Newark, New Jersey, graduated from the Ohio State University, Columbus, Ohio, with the degree of Mechanical in Electrical Engineering. During the summer months while at college, Mr. Schreiber was employed by the Electrical Department of Laclede Gas Light Co., St. Louis, Mo., inspecting and testing watt meters. Before he graduated, his father suddenly died. Martin Schreiber, Sr., was a general contractor and brick manufacturer, with quite extensive operations along the Ohio River, from Portsmouth, Ohio, to Catlettsburg, Ky. As a result of the father's demise, the son left college for a year and closed out his father's business, finishing several important contracts. Then he returned to college, and after graduation went at once into the employ of the Cleveland Electric Railway Company, Cleveland, Ohio. Here he was employed as electrician, doing wire work incidental to connecting up generators and switchboards in the Cedar Avenue Power House, and in electrolytic surveys. Then he was employed as draughtsman on power house designs and equipment. Next he was made engineer in charge of the drafting room, with supervision and construction of building and coal handling, and all other equipment, in connection with the extension of the Cedar Avenue Power House. In June, 1903, he resigned from the Cleveland Electric Railway Company and became assistant engineer of the Public Service Railway Company, having charge of a number of track extensions, and design and construction of new bridges and car houses. A year later a large number of bridges were carried away by action of floods at Paterson, N. J., and immediate vicinity. He was assigned to the task of putting a number of these bridges in safe operating condition for cars in the quickest possible time. It was during this time that he designed and built a pile trestle railroad bridge, with an electrically operated bascule draw span over the Passaic River, between Passaic and Wallington, in forty days. A unique feature of the bridge was an auxiliary truss to hold the trolley wire, that was automatically raised and lowered when the bridge was opened and closed. Although the bridge was only supposed to be used for a few months, it was operated for about two years. The jack-knife span could be opened and closed in four minutes; quite a contrast to the temporary wagon bridge alongside, which required thirty minutes to open and close to allow a boat to go through the draw. He was next assigned to the design and construction of the Plank Road Shops, now the Newark Shops, at Newark. These buildings are well known in the electrical railway field, and have been a show place for those interested in the design of modern shop buildings for electric railways. Many of the features and equipment in these shops, including the arrangement of buildings with transfer tables, have since been incorporated in other railway properties. Since 1906 he has been Engineer of Maintenance of Way and Chief Engineer of the Public Service Railway Company, that operates 900 miles of track in 146 municipalities in the state of New Jersey, serving a population of 2,800,000. The company also operates ferries across the Hudson River, between Edgewater, N. J., and 125th Street, New York, and over the Kill von Kull, between Bayonne, N. J., and Staten Island, N. Y. For twelve years he has had responsible charge of the design and construction of a large number of improvements for public service. Among the important operations are car houses, bridges, ferry slips and ferry houses, sand drying and stone crushing plants, and commercial buildings throughout the State representing millions of dollars. Included in this are car houses and shops at Camden, headquarters of the Southern Division and the Hoboken Terminal at Hoboken, where one may take elevated or surface street cars; ferries over the Hudson River; Delaware, Lackawanna and Western Railroad trains, or Hudson River Tubes to New York, all from under one roof. Then, there was extensive reconstruction of ferry properties that took in slips with their appurtenances such as

electrically operated bridges and new ferry houses. Among the track extensions was the so-called "Fast Line" from Elizabeth to New Brunswick, N. J., built after the best steam road practice, with continuous track automatic block signals. And more recently, he had charge of the design and construction of the new Public Service Terminal at Newark. This consists of a subway and trolley terminal and office building, combined. There are two train floors (elevated and subway) and a concourse, with show rooms on the street level. The building is of eight stories, with 394 rooms and ten acres of floor space. The building is of unique design and embodies all branches of high-class engineering. Various problems which involved unusual engineering skill were put up to Mr. Schreiber during the war. The Public Service Railway served many shipyards and munition plants and to accommodate these the company was forced to make extensions in Newark, Camden and Gloucester, the engineering and construction details of which were worked out under Mr. Schreiber's directions. Mr. Schreiber was a member of a committee reporting to the Public Service Corporation of New Jersey on the proposed vehicular tunnels under the Hudson River, between Canal Street, New York, and Twelfth Street, Jersey City. He has always taken a keen interest in the affairs of technical societies. He is Past President of the American Electric Railway Engineering Association, and has served on many committees of the American Electric Railway Association; he is a member of the American Engineering Standards Committee; the American Society of Civil Engineers; American Institute of Electrical Engineers; American Society for Testing Materials; National Electrical Light Association; the Electrical Committee of the American Railway Engineering Association; Representative of the American Electric Railway Association on the Electrical Committee of the National Fire Protection Association. Mr. Schreiber holds membership in the Engineers'; Transportation and New York Railroad clubs of New York; the Essex County Country Club of West Orange, N. J., and South Orange Field Club of South Orange, N. J., and the Alpha Tau Omega fraternity.

WILLITS H. SAWYER

Willits H. Sawyer was born in Schoolcraft, Michigan, October 30, 1873, and was graduated from the University of Nebraska in 1894.

He became connected with the Lincoln (Nebraska) Street Railway in 1890, afterward with the Evansville (Ind.) Street Railway, and the New Haven (Conn.) Street Railway until 1896. He was with the General Electric Company's Testing Department, 1896-1897; engaged in special test and construction of Surface Contact Systems in England, 1897; then in the Railroad Department in early development of the multiple unit system and in tests and construction of Manhattan Elevated, Brooklyn Elevated and Manhattan Subway, in New York, 1897-1905. He was with Ford, Bacon & Davis as engineer in charge of their New York office, 1905-1914; since then and now vice-president of E. W. Clark & Co. Management Corporation, in executive charge of railway and light and power companies. He is a member of the American Institute of Electrical Engineers, the Engineers' and Railroad Clubs, of New York, and Engineers' Club, of Columbus, Ohio.



WILLITS H. SAWYER

EDWARD SCHILDHAUER

EDWARD SCHILDHAUER

The work of the electrical engineer is of such variety and diversity that the Story of Electricity in its entirety touches nearly every important constructive enterprise of the past quarter of a century. Edward Schildhauer, of Indianapolis, is an electrical engineer who is possessed of constructive and engineering initiative which has enabled him to face and conquer many new and important problems of electrical engineering, and to become recognized as an important factor in the development of the electrical industry.

He was born in New Holstein, Wisconsin, August 21, 1872, and attended the common schools preparatory to a college education. From early boyhood he always had a desire to know something about electricity, and this desire crystallized into a determination to study it after visiting the Edison Power Stations in Milwaukee. He therefore entered the University of Wisconsin in a course, leading to the degree of Bachelor of Science in Electrical Engineering, with which he was graduated in the Class of 1897. The degree of Electrical Engineer was conferred in 1911.

After graduation, in 1897, he obtained employment with J. G. White & Company on electric street and interurban railway construction work in and around Baltimore, Maryland, for a year, and after that, from 1898 to 1906 he was with the Chicago Edison Company and the Commonwealth Electric Company (now the Commonwealth Edison Company) of Chicago. He started in the construction department of the Chicago Edison Company, was transferred to the drafting department as a draftsman, was promoted to chief draftsman, then became assistant to the mechanical engineer and finally assistant to the electrical engineer.

During this period the company's growth was very rapid. The number of substations increased from one to twenty-six; and while he was assistant to the electrical engineer, the Fisk Street Station, where the first 5,000-kilowatt steam turbine was installed, was developed. Naturally, during this period, a good many improvements were made in switchboard construction, and in the layout of substations to establish continuity of service. He therefore had a varied experience, and obtained several letters patent.

Mr. Schildhauer had thus progressed to a position where he had secured recognition as one of the most capable electrical engineers in the country, and this led to his appointment, in 1906, to the position of electrical and mechanical engineer of the Panama Canal, in which connection he had charge of all electrical and mechanical work connected with the locks and dams. This work consisted of designing, purchasing, inspecting, erecting, and operating all the apparatus required, including the steam stations for construction purposes, the hydro-electric stations and substations, and the transmission lines across the Isthmus.

It was a work of supreme importance, and one which presented new and difficult problems, the solution of which advanced electrical science and crowned with success the greatest engineering enterprise in which our Government had ever engaged. In the solution of these problems Mr. Schildhauer invented many devices for which he received letters patent.

Development of electrical devices for many new purposes ensued during the construction period on the Panama Canal. These embraced electric towing locomotives for hauling ships through the locks; remote control boards for controlling all gates, valves, and machinery of the locks, all interlocked to prevent incorrect operation; a miter-gate operating mechanism for closing and opening the huge miter-gates weighing upward to 700 tons each; and special mechanisms for operating cylindrical valves, spillway gates, emergency dams, and other lock equipment.

In July, 1914, the work of construction having been completed, Mr. Schildhauer resigned from the Panama Canal, after having completed the work of organizing the operating force.

Since then he has been engaged in the manufacture of munitions—such as loading and assembling 3-inch shrapnel and assembling 3-inch high explosive shells while General Manager of the New Castle Con-

struction Company of New Castle, Delaware; manufacturing and loading 21-second time fuses while President of the Artillery Fuse Company of Wilmington, Delaware, and, for the duration of the war, manufacturing and loading rifle grenades, Stokes trench-mortar fuses, etc., while President of the Stenotype Company, of Indianapolis, Ind.

His great achievements in connection with the completion of the Panama Canal were recognized by his alma mater, and in the college year 1912-1913 the Faculty of the University of Wisconsin conferred upon him the honor of placing a painting of his portrait in the University Hall of Fame, created to honor alumni of that famous institution who have gone out into the world and gained high distinction in their professional or public careers.

The Alpha of Wisconsin Chapter of Tau Beta Pi likewise honored him by electing him a member of the society—a deferred honor which he would have been entitled to in his student days had the chapter been in existence at that time.

Mr. Schildhauer is a member of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, American Society of Civil Engineers, illuminating Engineering Society, the Engineers' Club, Engineers' Country Club and Bankers Club of New York, Columbia Club and Country Club of Indianapolis, and the University Club of Panama.

FRANCIS HENRY SHEPARD

The use of electricity to supplement steam for train propulsion marks one of the greatest strides in the development of that force. When the electrification of heavy transportation lines was first considered, a number of electrical engineers undertook to solve the problem of power application. There were no precedents for guidance and in consequence several methods were evolved, some of which formed the foundations of modern practice while others proved themselves to be unfitted to give comprehensive and satisfactory operation.

Among the pioneers in railroad electrification was Francis Henry Shepard. Having taken up electrical work in his boyhood and having been connected with some of the early trolley car installations, he was in a position to take an active part in the construction and initial operation of the Baltimore Tunnel electrification, which was the first heavy tonnage railroad ever operated electrically. His experience and growing knowledge convinced him that the solution of the electric railroad problem lay in providing greater and more flexible power per train than was possible with the use of steam. He has always specialized in the electric railroad field, spending four years of much activity with Mr. Frank J. Sprague in the exploitation of the multiple unit system and participating in most of the important electrification work that has since been undertaken. His record of accomplishment in this line of endeavor has, therefore, been exceptional. Immediately after graduation from high school in 1889 he entered the employ of the Thomson-Houston Electric Company, as an assistant in the Construction Department. This company was installing a plant for the Mason City Electric Light Company, and upon its completion Mr. Shepard remained with the local company, doing line work, inside wiring and operating dynamos.

In April 1890, he went with the Chicago, Milwaukee & St. Paul Railway, where under the direction of the Mechanical Engineer, Mr. George Gibbs, he was engaged on train lighting and isolated plant work. In 1891 he transferred his energies to the West Side Street Railway Company of Milwaukee, one of the early Sprague roads, and there he did armature winding and repair work. In 1892 he was placed in charge of the armature room of the Milwaukee Street Railway Company, then the third largest electric railway in the country, and in the following year became its electrician in charge of car equipment and the electrical repair shop. While there he instituted a number of modifications in this

FRANCIS H. SHEPARD

early equipment to obtain greater reliability and this attracted considerable attention.

He left this position in October, 1893, to take the electrical course at the Massachusetts Institute of Technology, where he was admitted by special vote of the faculty without examination, a remarkable and most unusual occurrence. He remained at the Institute for eighteen months, when he was compelled to go to a hospital on account of an injury. While under treatment he was offered the position of assistant to the supervising engineer who was in charge of the installation of electric locomotives, line work and power-house for the Baltimore & Ohio Railroad at Baltimore. He continued this connection until 1896 when he was placed in charge of the work as supervising engineer. While located in Baltimore Mr. Shepard added materially to his knowledge of electricity by taking special instruction in electrical engineering under the late Dr. Duncan at the Johns Hopkins University. He completed the work of electrification and secured its acceptance. Leaving Baltimore, he was then promoted to become technical assistant to William J. Clark, General Manager of the Railway Department of the General Electric Company at New York, and in this connection he reviewed the original plans of the New York Subway and numerous other contemplated electric railway projects in various parts of the United States.

In January, 1898, he went with the Sprague Electric Company and became assistant to Mr. Frank J. Sprague in the exploitation of the multiple unit system. It was here under Sprague that Mr. Shepard was given opportunity for most energetic practical application to original electrical development. Mr. Sprague had created and developed the system and then had the contract for the installation of electric equipment on the South Side Elevated Railway Company, Chicago. The contract was completed in the most satisfactory manner despite the almost universal sentiment existing that the system could not possibly work and if it did, it would have no future. As the system with the vast traction possibilities it unfolded is now standard, it can be seen how erroneous were the opinions of the critics.

After leaving Chicago Mr. Shepard was engaged in the commercial and engineering exploitation of the Multiple Unit System on the elevated roads of Brooklyn, Boston and New York, and was largely responsible for the decision to use the Multiple Unit System on the New York Elevated Roads. In the Spring of 1902, the Sprague Electric Company having been acquired by the General Electric Company, Mr. Shepard engaged as consulting engineer for various interests, including railroads and the General Electric Company.

In September, 1903, he entered the employ of the Westinghouse Electric and Manufacturing Company and was associated with George Westinghouse in the development of electro-pneumatic control and on general railway engineering. He was active in the perfection of this method of control, which has since become universally standard and has been adopted by other large interests which originally opposed it. In general railway work Mr. Shepard has contributed to the development of engineering on numerous electric railway installations, among them being the Grand Trunk Railway; New York, New Haven & Hartford Railroad; Pennsylvania Railroad; Chicago, Milwaukee & St. Paul Railway; Norfolk & Western Railway; New York Municipal Railway Corporation and the Interboro Rapid Transit Company. Mr. Shepard is still associated with the Westinghouse Company as Director of Heavy Traction.

One of the chief characteristics that has made him an important factor in heavy traction is thorough knowledge of the possibilities of the industry and the needs of the railroads, together with that experience necessary for their conjunction. He possesses an analytical mind, a strong mechanical bent, with a vigorous brain to conceive and an uncommon amount of energy to execute the elements that must bring success. Added to these is a strong personality and a faculty of inspiring the best effort from the men associated with him. Mr. Shepard is the author of several articles on electrification and allied subjects and has taken out numerous patents on electrification methods and details. He is a member of the Engineers' Club, the

Lotos Club, the Railroad Club, the New York Athletic Club, Pittsburgh Athletic Club and the Wykagyl Country Club of New Rochelle, N. Y., where he makes his home. His business address is 165 Broadway, New York City.

DR. SAMUEL SHELDON

Dr. Samuel Sheldon, who has been Professor of Physics and Electrical Engineering at the Polytechnic Institute of Brooklyn since 1889, was born March 8, 1862, in Middlebury, Vermont. He graduated from the Middlebury College in 1883, with the A.B. degree, was the recipient of the A.M. degree in 1886 and the honorary degree of D.Sc. in 1911. He was winner of the Waldo Prize for four years; the

HENRY D. SHUTE

Second Botanical Prize; was Salutatorian of his class at graduation and received the highest honors in physics. He graduated from the University of Würzburg, Germany, in 1888, with the Ph.D. degree, and in 1906 the University of Pennsylvania conferred upon him the honorary degree of D.Sc. After leaving Germany he became assistant in Physics at Harvard University, and after one year's service at that institute of learning he went to Brooklyn, where he has since occupied the chair of Physics and Electrical Engineering in the Polytechnic Institute, devoting a portion of his time to private consulting practice. At different periods in his career Dr. Sheldon was consulting engineer and expert with the General Electric Company, the Westinghouse Electric Company, the New York Edison Company, the New York Central Railroad, the Cutler-Hammer Mfg. Company; the Rapid Transit Company, of New York; the City of Trenton, N. J., and the Swiss Government. He is senior author of "Dynamo Electric Machinery," "Alternating Current Machines," "Electric Traction and Transmission Engineering," "Physical Laboratory Experiments for Engineering Students," and has prepared many papers for engineering periodicals. Dr. Sheldon is a member of the Engineers' Club, president of the American Institute of Electrical Engineers, 1906-07; president New York Electrical Society, 1902-03; president John Fritz Medal Association, 1910; trustee of the United Engineering Society and chairman of its Library Board, 1916-17; member of the American Association for the Advancement of Science, and the American Electrochemical Society, and an Honorary Fellow of the Electro-Therapeutic Society. He is also a member of the Delta Kappa Epsilon Fraternity. Dr. Sheldon's office address is 85 Livingston Street, Brooklyn, N. Y.

HENRY D. SHUTE

As engineer, manufacturer, financier and sales manager, Henry D. Shute has attained a place of note among those who are in responsible positions in the electrical profession, and his recent promotion from treasurer to vice-president in charge of sales of the Westinghouse Electric and Manufacturing Company marks the capture of another round in the ladder of success for a man of recognized versatility of talent and steadfastness of purpose.

Henry D. Shute, who was born in Somerville, Massachusetts, August 1, 1871, is a scion of an old Colonial and Revolutionary family. After a thorough preparatory training he entered the Massachusetts Institute of Technology, imbued with a belief in the growth of the electrical industry and a desire to master it and participate in its expansion. He was graduated with the degree of Bachelor of Science in Electrical Engineering and then went to Germany and took a year's post-graduate work in the School of Mines at Clausthal, and in the Technical School at Dresden, Saxony. Returning to the United States, he entered the shops of the Westinghouse Electric and Manufacturing Company as a "student apprentice" on July 1st, 1893, and there continued to add to his excellent technical preparation the great advantage of full participation in the practical applications of electrical knowledge in which the Westinghouse work is a leading example and in many branches the pioneer. For two years he was in the testing department, where he familiarized himself with the entire line of machines and electrical devices produced by that great plant, and after that was put in touch with newer problems in connection with erecting and laboratory work. Later he was assigned, as assistant foreman, to the experimental department of the main East Pittsburgh works, in which many new and important problems were confronted and mastered. He was then transferred to the Engineering Department, giving his attention to design of alternating current apparatus, a branch of electrical progress in which the Westinghouse plant has been recognized as leading. With that work he completed the first five years of his connection with the Westinghouse Company, during which he had covered in an especially complete way the manufacturing and technical

details of the company's business and had proved his mettle as a valuable collaborator in those varied departments. He was then transferred to the Sales Department, to which he carried a full knowledge of the products he was called upon to sell, and he proved to be as much of a success in that department as he had in the shops, drafting rooms and laboratories. He spent five years in the Sales Department and was then made assistant to Vice-President, L. A. Osborne, where he was familiarized with duties executive and administrative in their character and was identified in a prominent and responsible way with the important work done by the Westinghouse Company in the electrification of steam railroads. In 1910 he was made Acting Vice-President, but in 1914 was transferred to the position of Treasurer of the company. The office of Treasurer is an important one in the Westinghouse Electric and Manufacturing Company, whose business, in addition to its manufacturing activities, involves the financiering of subsidiaries and the making of investments to a considerable extent. The treasurership, therefore, calls for a considerable degree of financial acumen and ability to judge the value of public utility bonds. Mr. Shute has the financial faculty to high degree and in his activities has acquired a great interest in the study of high-grade investments, concerning which he is exceptionally well informed. His promotion to the Vice-Presidency of the company, therefore, after a full-rounded experience in the manufacturing, sales and financial departments, brought to the office the highest order of ability for the larger duties that come to him. He has taken a large interest in Pittsburgh affairs and is a citizen of influence and prominence. He was an active member of the Pittsburgh Committee on the Anglo-French Loan and afterwards of the Manufacturers' Committee which had so large an influence in making the oversubscription by Pittsburgh to the Liberty Loan. Besides his office in the Westinghouse Electric and Manufacturing Company, he is a director of several manufacturing companies. He is a director of the Pittsburgh Chamber of Commerce, a member of the Duquesne, University, Pittsburgh Golf, and Oakmont Clubs, in Pittsburgh; the Engineers', Bankers', University and City Lunch Clubs, in New York; Sons of the Revolution, and Union Society of the Civil War. He is fond of outdoor life, hunting, fishing, sailing, golf, and other sports of the open.

S. D. SPRONG

An inherited aptitude for engineering led S. D. Sprong into the field of electricity, and his work in connection with the development of that industry has placed him among the leading electrical engineers of the country. Mr. Sprong was born at East Greenbush, Rensselaer County, N. Y., October 27, 1873. His birthplace is a small town in the vicinity of Albany, and it was there that his ancestors from Holland settled in 1642. Mr. Sprong was educated in the public schools and by private tutors, which was supplemented by a special course in electrical and mechanical engineering. In 1892 he secured a position in the armature department of the General Electric Company at Schenectady, N. Y., and the following year entered that company's student course to thoroughly equip himself with every detail of the business. After spending some time with the General Electric Company he was, in 1898, appointed superintendent of the electrical department of the Consolidated Gas Company of New Jersey, with headquarters at Long Branch. He remained in this position until 1901, when he became chief engineer of the Central Electric Company, Metuchen, N. J. He came to New York City in 1902 as assistant chief electrical engineer of the New York Edison Company, and retained his connection with that company until 1906, when he accepted a similar position with the United Electric Light, Heat and Power Company, New York City. After three years with this company J. G. White & Co., New York City, tendered him the position of chief electrical and mechanical engineer, and from 1909

S. D. SPRONG

until 1912 he handled the electrical and mechanical engineering for that firm. In 1912 he was made chief electrical engineer of the Brooklyn Edison Company, Brooklyn, N. Y., and still retains that position. During his long service, covering a period of over a quarter century, Mr. Sprong has devoted much time to investigation and research. In consequence of his efforts along this line he has taken out numerous patents applicable to electrical and mechanical work, many of which are in practical use. He has also made improvements in the practice of electric distribution and regulation, and has contributed various other devices that have materially aided in advancing the science. Mr. Sprong is a member of the Engineers' Club, New York City; Engineers' Club and Crescent Athletic Club, Brooklyn, N. Y.; member American Society of Mechanical Engineers and Fellow of The American Institute of Electrical Engineers, of which he is past manager and vice-president. His office address is 360 Pearl street, Brooklyn, N. Y.

FRANK WHITNEY SMITH

Frank W. Smith, Vice-President and General Manager of The United Electric Light and Power Company of New York City, has been identified with the development of alternating current distribution in Greater New York since first introduced by the Westinghouse interests through the medium of the United States Illuminating Company and its successor, The United Electric Light and Power Company.

During his active service of thirty-eight years with these companies, he was identified with the construction of the United Company's modern generating station at 201st Street and the Harlem River, now supplying 60-cycle service throughout the boroughs of Manhattan, Bronx and Queens, as well as to Westchester, etc., 25 cycle service also being supplied from this plant for the operation of the New York, New Haven & Hartford Railroad and the

Boston and Westchester Railroad Companies.

He was also identified with the design and construction of the Company's substations located at 354 West 45th Street, 519 West 146th Street, 654 West 187th Street, and the newer and modern substation at West Farms, through which the railway supply service is delivered, and in addition the modern and fireproof service building at 514 West 147th Street.

Mr. Smith is a director of the United Company, and Secretary of the Brush Electric Illuminating Company of New York, a subsidiary of the United Company. He is a director of the Electrical Show Company, a member of the American Institute of Electrical Engineers, New York Electrical Society, and is the Treasurer of the National Electric Light Association and a member of its Executive Committee, as well as a member of other societies and clubs, including the Engineers' Club and the Engineers' Country Club.

WARNER M. SKIFF

Warner M. Skiff, now manager of the Engineering Department of the National Lamp Works of the General Electric Company, was born in Jamestown, N. Y., October 5, 1883. He was educated in the Jamestown High School, and the Case School of Applied Science at Cleveland, Ohio, graduating 1906. He took special courses in electrical engineering, was elected to Sigma Xi, and became a member of the Phi Kappa Psi and the Tau Beta Pi fraternities. He secured employment with the engineering department of the National Lamp Works following his graduation in 1906, became greatly interested with the work and has continued there ever since. He has held various positions and has been responsible for a large number of different parts of the work. He was gradually advanced in the service and in 1913 he became manager of the Engineering Department. He is a member of the American Institute of Electrical Engineers, the Illuminating Engineering Society, the Jovian Order, Electric League of Cleveland, National Electric Light Association, the Cleveland Advertising Club and the National Association of Corporation Schools. Mr. Skiff is much interested in the subjects of organization and management, with particular reference to human engineering. Outside of his professional occupation, he is interested in outdoor recreations, camping, canoeing, fishing and motoring.

WARNER M. SKIFF

ELMER AMBROSE SPERRY

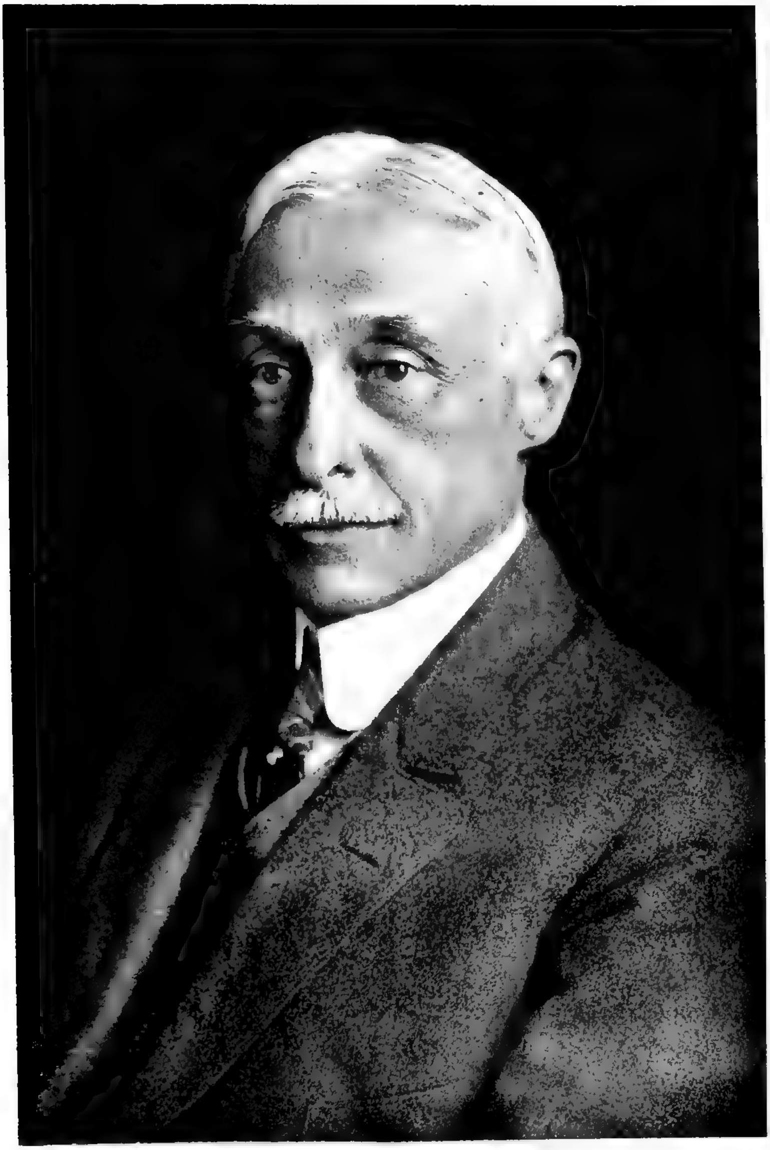
Elmer Ambrose Sperry, one of the earliest pioneers in the electrical field and an inventor with more than 250 patents to his credit, was born at Cortlandt, N. Y., October 12, 1860, the son of Stephen Decatur and Mary (Borst) Sperry. The founder of the Sperry family in the United States was Richard Sperry, who, while still a young man, emigrated from England in 1634 and joined the settlers of the New Haven colony in Connecticut. He occupies a prominent place in the early history of the country, for it was he who for a long time offered asylum and protection to the three "regicide judges," Goffe, Whalley and Dixwell, who were members of the court that condemned Charles I, of England, and who were obliged to flee the country to save their heads. On Sperry's farm at West Rock, near New Haven, was a cave in which he hid the three fugitives. His children carried food, which they left at a pre-arranged place in the forest for the hunted men to secure at night. This cave is one of the historic show places of New England and is known today as the Judges' Cave. Richard Sperry's son, Richard 2nd, built on this farm a stone house, which still stands and is occupied by his descendants, never having been out of the family's possession.

The subject of this sketch spent his boyhood in Cortlandt and was educated in the State Normal School of his native town. During the year 1879-1880 he attended Cornell University, and here his college career began and ended, his later education being the result of self-training, study and practical experience.

In 1879, and before he had arrived at the age of twenty years, young Sperry had invented and secured the practical adoption of one of the earliest arc lights invented in the United States. In the following year, although not yet of age, he had founded his own business, the Sperry Electric Company, of Chicago, and had begun the manufacture of arc lamps, dynamos, motors and other electrical appliances. This was but the beginning of a series of industrial and manufacturing enterprises founded by Mr. Sperry to market the products of his inventive genius, all being conspicuously successful. In 1883 he erected on Lake Michigan the highest electric beacon in the world, consisting of a tower 350 feet high equipped with arc lamps aggregating 40,000 candle power. He entered a competition in 1888 and won the distinction of being the first to produce successful electrical mining machinery. His inventions in this field cover a broad range of appliances, including reciprocating mining machinery, rotary and chain cutting equipment and electric locomotives for mines. The Sperry mining devices, from the time of their initial appearance, have ranked among the best known and most widely used of their class and represent a most profitable field of business.

Shortly after this success with electrical mining machinery, Mr. Sperry appeared as a practical designer of electric railway cars and founded the Sperry Electric Railway Company, of Cleveland, Ohio, to manufacture them. This business was continued with profit and success until 1894, when the patents and stock were purchased by the General Electric Company. The transition from the electric railway car to the electric motor vehicle was an easy and natural one for Mr. Sperry. At the time when the earliest pioneers in the gasoline automobile industry were still making their experiments Mr. Sperry designed, built and sold a successful electric vehicle. He also drove the first American built automobile in the streets of Paris in 1896 and 1897, where a large number of these automobiles were sold and delivered.

An important commercial process for the production of caustic soda and bleach, used by the Hooker Electro-Chemical Company, of Niagara Falls, N. Y., is the



ELMER A SPERRY

result of Mr. Sperry's activities in the field of electro-chemistry. The National Battery Company was organized and is operating under other electro-chemical patents issued to Mr. Sperry. He also invented a detinning process used by the American Can Company and machinery for producing fuse wires, on which the business of the Chicago Fuse Wire Company is founded. He also was instrumental in designing machinery for the General Electric Company, the Goodman Manufacturing Company and others.

About 1890 Mr. Sperry first turned his attention to what, thus far, has been the most important work of his useful career. He was attracted to the immense possibilities of the gyroscope, which, since its first demonstration by the French scientist Foucault, in 1851, had been little more than a scientific curiosity or a mathematician's toy, embodying intricate and obscure physical principles. Within the decade beginning about 1898, however, the phenomena of the gyroscope suggested to a number of inventors great possibilities in stabilizing ships at sea and the operation of single rail tram cars. But none arrived at commercial success until Mr. Sperry's invention of the gyroscopic compass, a remarkable contribution to practical mechanics. The principle involved had been known since Foucault's days. The action of any given gyroscope is precisely similar to that of a "mechanical magnet" and it also shows the effect of "polarity," since the direction of rotation, "clockwise" or "counter-clockwise," determines which end of the rotating axis points to the north. Mr. Sperry abandoned the mercury floats used by previous experimenters and reduced the whole gyroscopic proposition to a strictly mechanical basis within easy comprehension of the man of average intelligence and containing no unknown quantities. He devised the beautiful method of driving his gyroscope by using the wheel rim as the rotor of a three-phase electric motor, and thereby reduced the gyroscopic compass to a perfectly practical basis greatly superior to the magnetic compass. The master compass may be placed in any safe part of the ship and the record read from "repeating instruments" in any other part, the connection between them being electrically made.

Mr. Sperry now undertook to solve successfully and practically the problem of stabilizing ships. With the results of a long series of experiments at his command, and proceeding upon thoroughly scientific lines, he set himself to the task of placing, mounting and driving the stabilizer so as to secure the maximum effect under all conditions with the minimum of machinery and stress. The apparatus of a number of previous inventors had depended upon a certain periodicity in the movements of the vessel. With Sperry's gyroscope the periodicity of the vessel is immaterial, for the apparatus responds to whatever motion the ship has, synchronous or non-synchronous. In other words, all rolling of the ship is prevented because the ship never begins to roll, the tendency to roll being corrected instantly in its incipiency. A ship stabilized by means of the Sperry devices possesses many technical advantages besides these that are obviously apparent. These include level gun platforms, comfort for passengers and crew, saving livestock in transit, and preserving the ship's structure from excessive wrenching and stress. The Sperry stabilizer already has been applied most successfully to many vessels ranging in size from a 60-foot scout boat to a 10,000-ton transport.

With the advent of the aeroplane came the problem of preventing the new device from losing its balance in the air and being precipitated to earth, and of lessening the too frequent accidents in the early days of human flight. The apparatus invented by Mr. Sperry to meet this important defect of flying machines seems to be the only efficient solution of the problem yet devised. In recognition of his invention of the aeroplane stabilizer he was awarded in December, 1914, the Collier Trophy, offered for "the most valuable contribution to aeroplane construction and operation during the current year." He also received the Collier Trophy for the year 1916 for his "Drift Set."

Mr. Sperry's many achievements have

been recognized by learned societies and also by the Aero Club of France, which awarded him its first prize for his gyroscopic aeroplane stabilizer; by the Franklin Institute of Philadelphia, which awarded him its medal for his gyro compass for ships; by the American Museum of Safety, which awarded him the 1915 "Scientific American" medal for the gyroscopic compass and stabilizer; and by the Panama-Pacific Exposition, which awarded him the Grand Prize for his Gyro-Compass.

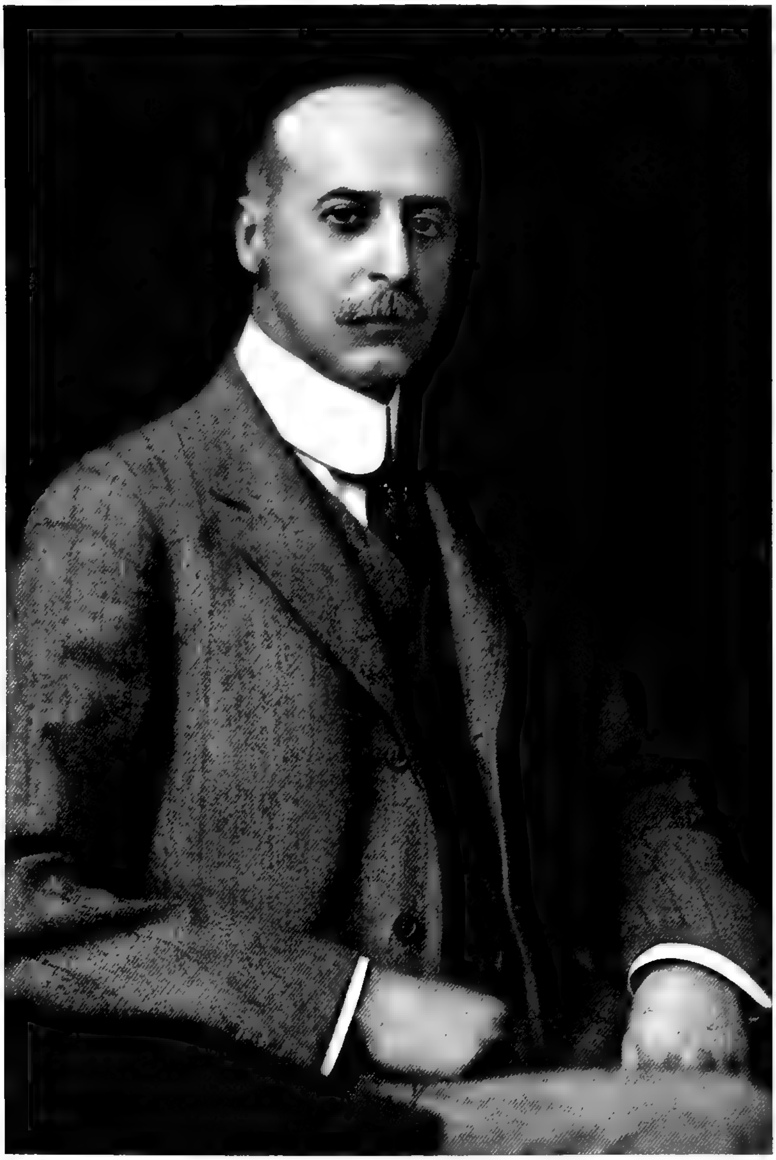
One of Mr. Sperry's latest inventions is a form of electric arc searchlight of extraordinary brilliancy which uses carbons manufactured in the United States under his direction. The intense beam sent forth by this new projector may be appreciated when it is stated that the candle-power per square millimeter of the tungsten filament in a nitrogen filled incandescent lamp, such as are common on our streets and in stores, is from 10 to 20. In the Sperry arc the candle-power is, on the average, 500 per square millimeter. The sun, at 30 degrees elevation, has 775 candle-power per square millimeter.

Mr. Sperry was married in 1887 to Miss Zula Augusta Goodman, a daughter of Edward Goodman, proprietor of the "Standard," of Chicago. They have a daughter and three sons—Helen Marguerite Sperry, Edward Goodman Sperry, Lawrence Borst Sperry and Elmer Ambrose Sperry, Jr.

The principal scientific and engineering societies carry Mr. Sperry's name on their membership rolls. He is a founder of the American Institute of Electrical Engineers and of the American Electro-Chemical Society; a member of the American Society of Mechanical Engineers, the Society of Naval Architects and Marine Engineers, the Society of Automotive Engineers, New York Electrical Society, the American Chemical Society, the Aero Club of America, the Engineers' Club of New York; the Hamilton Club of Brooklyn; Marine and Field Club, and a governor of the Engineers' Country Club, of Roslyn, Long Island.

PAUL SPENCER

Paul Spencer, now of Philadelphia, has had a progressively successful career in his profession of electrical engineer. He was born in East Orange, New Jersey, March 19, 1866, the son of George Gilman and Caroline (Arnold) Spencer. His father, George Gilman Spencer, came from Hartford, Connecticut, and was a graduate from Yale College, in the Class of 1834. The paternal descent of the Spencers goes back to an ancestor who came from England to Massachusetts in 1632, and in 1634 removed to Hartford, Connecticut. Paul Spencer was graduated from Yale with the degree of A. B., in the Class of 1887, taking the Senior Year honors in the physical sciences. His general liking for these sciences, and especially for electricity, together with the fact that at the time of his graduation from Yale electricity was attracting wide attention as presenting exceptional opportunities for talent and enterprise, led him to adopt electrical engineering for his profession. He therefore entered the Stevens Institute of Technology, from which he was graduated with the degree of M. E. in 1891. Immediately after his graduation from Stevens he engaged with the Field Engineering Company, building a trolley road in Paterson, N. J., and continued with the company until 1894. He was then with the Stanley Engineering Company from 1895 to 1898; was General Superintendent of the People's Light and Power Company of Newark, N. J., from 1898 to 1900, when he accepted the position which he has held ever since of electrical engineer of the United Gas Improvement Company of Philadelphia. Mr. Spencer's professional duties keep him fully occupied, and his standing



PAUL SPENCER

in the profession is among the leaders. He is a Fellow of the American Institute of Electrical Engineers, was a manager of the Institute, 1907-1909, and its Vice-President 1909-1911. He is a member of the National Electric Light Association, and has been a manager of the Association from 1914 to date. He is an associate member of the Naval Consulting Board, a member of the Franklin Institute and of the Illuminating Engineering Society. He is also a member of the Delta Kappa Epsilon Fraternity, and of the following clubs: The Racquet, of Philadelphia; Merion Cricket, of Haverford, Pennsylvania; Engineers, of Philadelphia, of which he is one of the Directors; the University, of New York, and the Graduates, of New Haven.

MARCELLUS STALEY

It has been said of the invention of the elevator that it created the modern city by making it feasible to build houses high and make all floors accessible. This fact has been especially accentuated by the application of electricity to the work of furnishing power to freight and passenger elevators. It has been a valuable accession to

MARCELLUS STALEY

the equipment of large buildings in cities where most passenger and very many freight elevators now owe their ease, safety and celerity of motion to the adoption of electrical propulsion. As an electrical engineer, who has devoted particular attention to this department of the electrical profession, Marcellus Staley, of New York city, has attained a place of considerable prominence. He was born in Dayton, Ohio, December 31, 1875, and is of an old Ohio family. His grandfather used to operate a dray between Cincinnati and Dayton, Ohio, several years before the first railroad was built in that region. Mr. Staley was educated in the public and high schools of Dayton, then entered Ohio State University at Columbus, Ohio, from which he was graduated with the degree of Electrical Engineer in Mechanical Engineering in the Class of 1899. After graduation he was engaged for two years as electrician of the United States Army Transport "Meade," in the Philippine service, at the end of which he returned to New York. It was necessary to find some employment in the line of his profession, and he started in with his tool bag and a partner to contract for electric elevator repair work. His previous experience had developed in him a special faculty for success in trouble-hunting on electrical machinery, which he rightly regarded as a valuable equipment for an elevator repair contractor. He has been engaged in that business ever since, becoming recognized as one of those best qualified to cope with the intricacies of remedying defective machinery, and has made continuous effort toward improvement in the construction and operation of elevators, especially those embodying devices by which electric control has been made more perfect and more immediately responsive to the touch of the operator. Mr. Staley has supervised the equipment on the elevators of many of the largest and most important commercial and office structures in the metropolitan area. Continuous improvement and development in electrical apparatus and machinery of this kind has marked each succeeding year of his engagement in the business, and his work has constantly been in the direction of further advancement in the design and operation of electric elevators. As a specialist of unique experience his services are much in demand and his place is one of leadership in the profession to which he has so long been devoted. Mr. Staley is a resident of the Bath Beach section of Brooklyn, N. Y., and has his offices at 136 Prince Street, New York city. He is a member of the Ohio Society of New York, president of the Bath Beach Taxpayers Association; is a prominent Mason with thirty-second degree, Scottish Rite, and a member of Kismet Temple, Mystic Shrine.

LEWIS B. STILLWELL

LEWIS BUCKLEY STILLWELL

Lewis Buckley Stillwell was born in Scranton, Pa., in 1863, being descended in the eighth generation from one Nicholas Stillwell, an Englishman, who came to America from Holland in 1638, settling in New Amsterdam. The Civil List of the State of New York shows the family to have been prominent in the affairs of the Province, only one name (Van Rensselaer) occurring more frequently among the members of the Colonial Assemblies prior to the Revolution. For the last century Pennsylvania has been the home of Mr. Stillwell's immediate ancestry.

Mr. Stillwell was prepared for college at the High School, Scranton, Pa., and entered Wesleyan University, Middletown, Conn., in September, 1882. At the end of Sophomore year he left Wesleyan and entered the electrical engineering course at Lehigh University, completing this course in 1885. During the following year he pursued special studies in mechanical engineering at Lehigh, and in October, 1886, was appointed Assistant Electrician of the Westinghouse Electric and Manufacturing Company at Pittsburgh. Here he became associated with O. B. Shallenberger, William Stanley, Nikola Tesla and others, who were doing pioneer work in alternating currents, and the next four years were devoted to development work in this highly interesting field. During the summer and autumn of 1887 the Westinghouse Company installed at New Orleans an alternating current lighting plant, which at that time was the largest in America, if not in the world. The belt driven alternators were not connected in parallel, but the feeders which they supplied were carried upon the same pole line for a distance of about two miles. When commercial service began, the intensity of the lights fluctuated rapidly and to an extent sufficient to destroy the value of the system. At that time the phenomena of mutual induction of adjacent circuits had not been encountered in commercial practice, and for a few days the officers of the company feared that the alternating current system was a failure. Mr. Stillwell was sent to New Orleans and, fortunately, was able within thirty-six hours to locate the trouble and correct it by transposing some of the circuits. In 1889, and again in 1890, Mr. Westinghouse sent him to Europe to investigate electrical developments abroad. He traveled extensively through Great Britain and on the continent, meeting many prominent electrical inventors and studying the results of their work. Returning to Pittsburgh, in August, 1890, he took up the matter of direct connection of engines and dynamos, belt drive having been used exclusively in the United States up to that time and, as chairman of a committee appointed by Mr. Westinghouse, directed an investigation which before the end of that year led to the adoption by the Westinghouse Company of two standard frequencies, namely, 30 cycles per second and 60 cycles per second. At a later date 25 cycles was substituted for 30, owing to the fact that the speed of the hydraulic turbines ordered by the Niagara Falls Power Company, and consequently that of the direct-connected generators, had been fixed at 250 r.p.m.

While in London, in 1889, Mr. Stillwell met Mr. Edward D. Adams of New York and Dr. Coleman Sellers of Philadelphia, who had gone abroad to consult with the leading scientists and engineers of Europe in regard to the possible utilization of power at Niagara. Mr. Westinghouse decided that his company would not compete in presenting plans, as invited by the Niagara Commission, which was organized by the Niagara Falls Power Company in 1890; but from the time of his first meeting with Mr. Adams and Dr. Sellers, Mr. Stillwell gave much of his time and thought to the development of the polyphase alternating current system, with special reference to the Niagara situation, and in 1892 and 1893 directed the technical development of the plans which, in the final competition of manufacturers, secured for his company the initial contract for three 5,000 horse-power alternators. In 1890 Mr. Stillwell became Chief Engineer of the company, and from that time he devoted his attention especially to the development of apparatus for transmission of power. In 1892 he made a long tour through the West to investigate and report

to his company upon the commercial possibilities of electric power transmission, and following the award of the Niagara contract, in the following year, he assumed immediate charge of construction and installation of the first great power plant at the Falls.

In March, 1897, he severed his connection with the Westinghouse Company and was appointed Electrical Director of the Niagara Falls Power Company and the Cataract Construction Company. In addition to the technical direction of the work of these companies, he took charge of the operation of the plant, reorganizing both methods and personnel. While still at Niagara he was retained as Consulting Engineer by the Manhattan Railway Company of New York in connection with the equipment of the elevated lines in that city, and in September, 1900, having completed the installation of the first 50,000 horse-power plant at Niagara and the organization of the operating force, he resigned his position with the Niagara companies and removed to New York.

In November of the same year he was appointed Electrical Director of the Rapid Transit Subway Construction Company, having charge at that time of the electrical equipment of both the elevated railways and the subway system of New York City. After completing the equipment of the elevated lines and the original Interborough subway system, he became Consulting Engineer for the Hudson Companies in charge of electrical equipment of the four tunnels constructed between Manhattan Island and New Jersey. In the design and construction of the great power house of the Interborough Company at Fifty-ninth Street, Mr. John Van Vleck, who since the earliest days of the New York Edison Company had done remarkable pioneer work for that company, became associated with Mr. Stillwell as Mechanical Engineer of the Interborough Company, and in the equipment of the lines of the Hudson Companies this association was continued. The entire mechanical and electrical equipment of the lines, with the exception of the signal system, were directed by Mr. Stillwell and Mr. Van Vleck, and it was in connection with this work that Mr. Stillwell and his assistant, Mr. F. M. Brinckerhoff, developed the side truss construction of steel passenger cars, which results in a material saving of weight and at the same time a marked increase of strength. In 1905 Mr. Stillwell was a member of a commission formed by the Erie Railroad Company to report upon electrification of some of its lines. In 1906 he undertook the reconstruction and extension of the power system of the United Railways & Electric Company of Baltimore, a work since carried to completion with most satisfactory results. In 1912, at his suggestion, the construction of a large power plant was undertaken by the Lehigh Navigation Electric Company, near Lansford, Pa. This plant, which supplies electric power to many cement mills, mines and public utilities in Eastern Pennsylvania, burns anthracite coal of the smallest screened size in combination with still smaller material which otherwise would be wasted, and is a striking example of true conservation of natural resources.

While carrying on his extensive work during the last fifteen years, Mr. Stillwell has associated with himself, from time to time, a group of partners of exceptional experience and ability, including Mr. H. S. Putnam, Mr. Hugh Hazelton, Mr. M. G. Starrett and Mr. F. M. Brinckerhoff, who, with him, constitute the membership of the firm L. B. Stillwell, Consulting Engineers.

Among other important undertakings not above mentioned which have been carried out by the firm are the electrification of the Hoosac Tunnel of the Boston & Maine Railroad Company, the rolling stock equipment of the New York, Westchester & Boston Railway, and the mechanical and electrical plans and specifications for a large central steam heating and power plant at Washington, D. C.

Mr. Stillwell has received the honorary degrees of M.S. and Sc.D. from Lehigh University and the degree of Sc.D. from Wesleyan University. He is Past-President of the American Institute of Electrical Engineers, member of the American Institute of Consulting Engineers, American Society of Civil Engineers, British Institute of Electrical Engineers, American Philosophical Society, British Society of Arts, and of the American Association for the Advancement of Science. His clubs are the Century, Engineers', Re-

RAY P. STEVENS

cess and Railroad Clubs of New York, and the Cosmos Club of Washington, D. C. In 1916 he was appointed a member of the National Research Council.

In the electrical field Mr. Stillwell has taken out numerous patents, especially in relation to the regulation and control of alternating current circuits. The original broad patents covering inductive regulation were issued to him in 1888. He is the inventor also of the method now universally used to localize interruptions of service by means of time limit circuit breakers and of the method of pilot switchboard now generally used in large plants to guide the operators in the manipulation of power circuits.

In the mechanical field he is joint inventor with his partner, Mr. F. M. Brinckerhoff, of the system of framing steel passenger cars, which makes each complete side of the car from underframe to deck a truss girder, and of the anti-telescoping bulkhead construction in which the upper or compression member of the truss is utilized for longitudinal support of the upper end of a steel bulkhead at each end of the car.

Mr. Stillwell has contributed a number of papers to proceedings of various societies with which he is connected, and to periodicals. Among the most important of these are "The Electrical Transmission of Power from Niagara Falls," Proceedings A. I. E. E., August, 1901; "Electrical Power-Generating Stations and Transmission," International Engineering Congress, 1904; "Electric Power Generation at Niagara," Cassier's Magazine, 1905; "On the Substitution of the Electric Motor for the Steam Locomotive," Proceedings A. I. E. E., 1907; "Notes on Electric Towage of Canal Boats," Proceedings A. I. E. E., March, 1980, and "The Relation of Water Power to Transportation," Proceedings A. I. E. E., April, 1916. In the preparation of the papers on "Substitution of the Electric Motor for the Steam Locomotive" and "Notes on Electric Towage of Canal Boats" his associate, Mr. H. St. Clair Putnam, collaborated.

In 1892 Mr. Stillwell was married to Mary Elizabeth Thurston, of Pittsburgh. They have one son and reside at Lakewood, N. J.

RAY PARKER STEVENS

The interurban trolley system that now gridirons the entire country and makes cities and small communities readily accessible, is as remarkable in its development as the telephone, which changed the rural dwellers' condition from a state of comparative isolation to one of social and business inter-communication. Among those who were the first to recognize the possibilities of development of such systems was Ray P. Stevens, whose development of the electric railways of Eastern Pennsylvania, Western Pennsylvania and Eastern Ohio resulted in increased earnings, improved service along original lines, and greatly enhanced values of real estate in the towns reached by the lines. Mr. Stevens is a practical electrical engineer who has made a close study of light and power and trolley transportation problems, and there is, therefore, no element of luck in his achievement, the success of the corporations in which he is interested being due to keen business judgment and familiarity with the smallest detail of the electric trolley service. Mr. Stevens was born April 3, 1877, in Eastport, Maine, the son of Simon G. and Abbie Parker Stevens. The father was a successful fish canner and promoter, and Mr. Stevens' ready grasp of commercial and financial conditions is undoubtedly inherited from his sagacious New England ancestors, who in early Colonial days faced and overcame obstacles that would have daunted those less intrepid. Mr. Stevens attended the schools of his district, after which he became a student at the High School, Ellsworth, Maine, and later took a preparatory course at the East Maine Seminary, Bucksport, Maine. He subsequently graduated from the University of Maine with the degree of B.M.E., in the electrical engineering course. His first employment after leaving college was with the Electrical Wiring and Supply Company, Bos-

ton, Massachusetts, after which he entered the student-service of the Bell Telephone Company in that city, later going to the General Electric Company, Lynn, Mass., where he took the students' course in preparation for engineering, construction and operation work. Following this he was engaged in building and operating electric light and power plants in the South for the General Electric Company, resigning to accept a position with the Automatic Fire Alarm Company of Boston, as superintendent of the Western Department, with headquarters in Chicago.

While practicing as a consulting engineer, Mr. Stevens built, at Everett, Washington, an entirely new railway and light and power system, including tracks, power house, distribution lines, shops and cars. Following this he was induced to accept, tentatively, the engineering and management of the railway and lighting properties in Everett, and his careful supervision resulted in doubling the earnings in less than five years, this being the turning point in his career from consulting engineer to engineering and management. In 1903, Mr. Stevens electrified the Everett branch of the Northern Pacific Railway, probably the first such steam railroad electrification in this country. Charles S. Mellen was president of the Northern Pacific at that time, and the success of the Everett venture doubtlessly led to the electrification of the New Haven lines, after Mr. Mellen became president of the last-named system. Mr. Stevens left Everett to accept the position of general superintendent of the Auburn & Syracuse Electric Railroad Co., in Auburn, N. Y., and of general manager of the Skaneateles Lake Transportation Company.

In July, 1907, he was elected president of the Lehigh Valley Transit Company and the Lehigh Valley Light and Power Co. Mr. Stevens established limited Pullman service between Allentown and Philadelphia, and erected the South Eighth Street Bridge in Allentown, at the time the greatest reinforced concrete bridge in the world. During Mr. Stevens' administration in Allentown, after six years of untiring labor, eighteen electric light and power companies were organized and developed in the Lehigh Valley and consolidated into the Lehigh Valley Light and Power Co. In August, 1913, Mr. Stevens resigned as president of the Allentown companies to become president and chief engineer of the Mahoning and Shenango Railway and Light Company and its subsidiary interests, with headquarters at Youngstown, Ohio. Upon the formation of the Engineering and Construction Department of the Republic Railway and Light Company, Mr. Stevens, in addition to his other positions, was made vice-president and engineering manager of the Republic Railway and Light Company, and in March, 1917, he transferred his office from Youngstown, Ohio, to 60 Broadway, New York City. In May, 1918, Mr. Stevens was elected President and Engineering Manager of Republic Engineers, Inc., Consulting and Constructing Engineers, still retaining his position as vice-president and a member of the executive committee of the Republic Railway and Light Company, and president of the Mahoning and Shenango Railway and Light Company, the Pennsylvania Power Co., Shenango Valley Electric Light Co., and the New Castle Electric Co. He is also a director and member of the executive committee of The Cleveland Electric Illuminating Company and Central States Electric Corporation.

Mr. Stevens is a member of the American Committee on Electrolysis. He has given many years of study to this subject, and in connection with the other members of the committee, is preparing an exhaustive report on the subject. He is a member of the Joint Committee on Specifications for Overhead Lines and Crossings, appointed by the Pennsylvania Public Service Commission, a member of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, and is vice-president of the American Electric Railway Transportation and Traffic Association.

Mr. Stevens is a member of the Masonic Fraternity, the Livingston Club, Allentown, Pa.; Youngstown Club, Youngstown, Ohio; Lawrence Club, New Castle, Pa.; Benevolent and Protective Order of Elks, the Phi Gamma Delta Fraternity, Bankers Club, New York City; Crescent Athletic Club, Brooklyn, and the Manhasset Yacht Club of Long Island.

Mr. Stevens was married in Islesboro,

FRANK H. STEWART

Maine, August 5, 1903, to Brina C. Pendleton, of that city, daughter of Captain and Mrs. Fields C. Pendleton, and two children were born to them, Edwin P. Stevens, born July 27, 1909, and Alice P. Stevens, born October 16, 1911.

FRANK H. STEWART

On the commercial side of the Electrical Industry one of the leaders who has elected to be exclusively a jobber and dealer in electrical supplies and to devote his attention entirely to that branch of the business is Frank H. Stewart, the President of the Frank H. Stewart Electric Company, of Philadelphia.

He was born in Mannington Township, Salem County, New Jersey, May 7, 1873, and is of an old Colonial family, the proper spelling of whose name is "Steward," the first American ancestor being Joseph Steward, who came from Cheshire, England, in 1682, to the Delaware River in the ship "Submission."

His father was Eli Stewart and his mother, Mary E. (Burnett) Stewart, daughter of Capt. Sam'l L. Burnett of Port Republic, N. J. The first ancestor of his mother in America was Thomas Burnett of Southampton, Long Island (1643).

In 1896 Mr. Stewart married Miss Rose Kirby of Woodstown, N. J. Her ancestors of the Kirby line were early settlers of Plymouth Colony, Mass. (1630).

Frank H. Stewart was educated in country schools in Sharptown, Halltown and Woodstown, New Jersey, clerked four months in 1890 in the Rogers store at Sharptown, graduated from school in 1891, and then worked for four months as a clerk in the office of the Philadelphia *Item* (newspaper), meanwhile entering upon a complete business course in Prickett's Business College in Philadelphia, from which he was graduated at the head of his class in 1892. As a well-equipped bookkeeper and stenographer he began work with O. D. Pierce & Company, electrical contractors and dealers, in May, 1892, and continued there until that firm retired from business in January, 1894. During his last year of service with that firm he worked as a traveling salesman, selling electrical supplies.

The retirement of O. D. Pierce & Company left him without a job, and, although he had excellent qualifications, he could not find one, owing to the panic conditions. Perhaps it was good for him that jobs were scarce, for he decided to start for himself. He had learned much about the electrical business and had in 1892 compiled the first general catalogue of electrical supplies ever issued by a Philadelphia electrical concern. In starting his business he determined to divorce the sale of supplies from the business of electrical contractor, for in visiting the contractors he had found that they were not greatly pleased to buy supplies from a competitor, for all the dealers in Philadelphia were also contractors at that period. Therefore Mr. Stewart became the first jobber in electrical supplies exclusively in Philadelphia.

His business was small to begin with, and in 1896 he formed a partnership with P. Logan Bockius. A few months proved that the business was not yet big enough for two, so that the firm of Frank H. Stewart & Co. was dissolved by the purchase of the interest of Mr. Bockius by Mr. Stewart. From 1900 the business grew rapidly, and in 1904 it was incorporated under the present name, in order to admit of participation of employees in the management. The premises occupied at 35 North Seventh Street having been outgrown by 1907, Mr. Stewart bought the property of the first United States Mint buildings, adjoining 35 N. 7th. These buildings were the first Federal buildings in the country for which Congress appropriated money. Upon that site he erected an addition to his business premises, but later tore down the old buildings and erected the steel and concrete structure now occupied, which was when erected in 1911 the best and most complete electrical supplies building in the country.

Mr. Stewart has always been active in measures for the uplift and progress of the electrical business. In connection with the late George Vallee he called the first meeting that resulted in the formation of the Electrical Trades' Association, the first coöperative movement of its kind in the industry, and now an international institution. He attended the first meeting of the Electrical Supply Jobbers of the Atlantic coast and was active in it for many years, and for two years chairman of its Atlantic (or Eastern) Division.

He is a collector of electrical relics, rare coins, Indian relics and historical works, and is the author of several publications, principally of an historical nature.

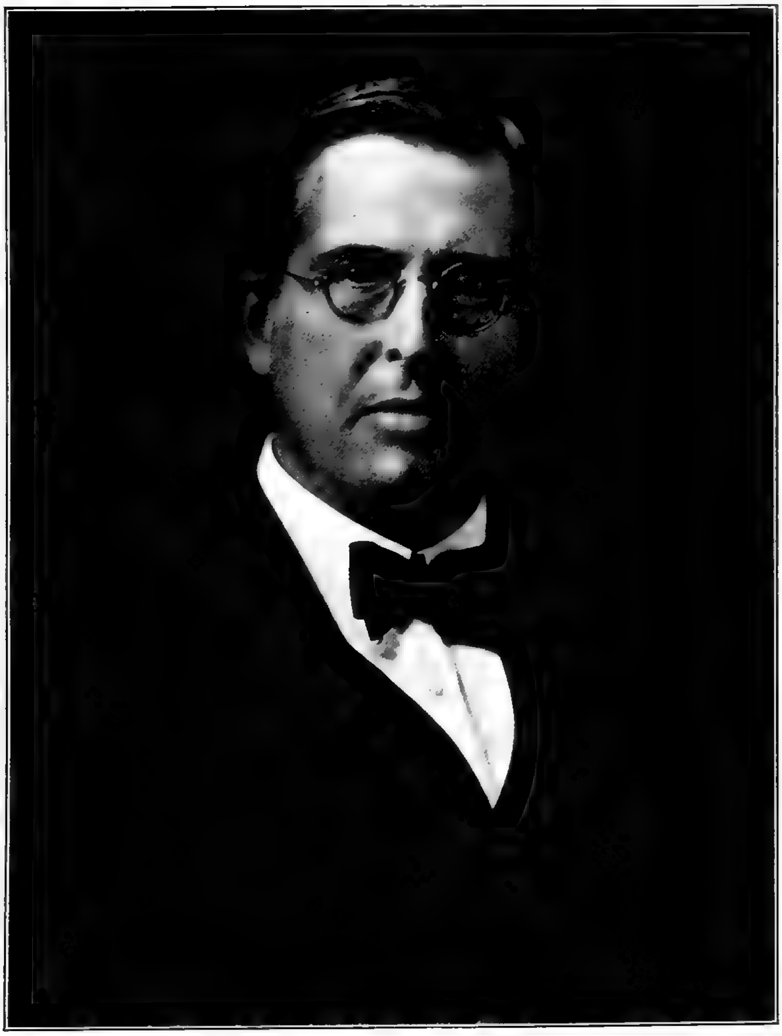
He is president of the Ocean City Fishing Club, director and historian of the New Jersey Society of Pennsylvania, director of the Genealogical Society of Pennsylvania, Vice-President Twentieth St. Improvement Association of Ocean City, Vice-President Woodbury Country Club, President North Pitman Land Co., President Gloucester County Historical Society, ex-Vice-President Pitman Cottagers' Association, Vice-President Electric Club of Philadelphia, ex-President and member of Pitman Masonic Club, ex-Vice-President and member of Rotary Club of Philadelphia, ex-Director and life member of Camden Y. M. C. A., member of Franklin Institute, Union League, Engineers' Club, Historical Society of Pennsylvania, and member of the Educational Committee of the Chamber of Commerce of Philadelphia.

GEORGE H. STICKNEY

The wonderful strides made in the electric illuminating field during the last few years is aptly told in the record of the work of George H. Stickney, whose achievement along this line was recognized by his election to the office of President of the Illuminating Engineering Society, which election was confirmed by the Council at a meeting held June 14, 1917. Mr. Stickney is one of the best known illuminating engineers in the country and has devoted much time to research work. He is a great organizer and constructive executive. The spirit to coöperate characterizes everything he undertakes.

Mr. Stickney was born in Buffalo, N. Y., in 1872. He graduated from Cornell University with the degree M.E. (E.E.) in 1896 and immediately after graduation went to the General Electric Company's works at Schenectady, where he spent a year and one-half in the student course. While working in this course, Mr. Stickney became interested in lighting and foresaw the wonderful future of electric illumination. He became affiliated with Mr. W. D'A. Ryan at the Lynn works as his first assistant. This was long before the days of illuminating engineering as an art or science, and Mr. Ryan's organization is to be credited with a great deal of pioneer work which eventually led to the establishment of the society.

For a period of about thirteen years, Mr. Stickney continued along this line of activity, doing much development work in photometry and in the design of arc lamp equipments. He spent a large portion of his time in analyzing the application of light-appliances, and largely through his efforts arc lamp illumination was placed on more definite ground. In 1911, when the Edison Lamp Works of the General Electric Company decided to establish a separate department to handle the general questions of illuminating engineering as to incandescent lamps, Mr. Stickney, with his broad knowledge of the entire field of lighting, was the logical choice as the man to organize such a division. For some time he had observed the rapid strides of advance the incandescent lamp was making, and the new line of work appealed strongly to him. He was accordingly transferred to Harrison, N. J., as assistant to the sales manager, which position he now holds. A number of lighting appliances have been developed under his direction. Of later years, however, he has extended his field of activity and become vitally interested in the very broad question of the general education of the public



GEORGE H. STICKNEY

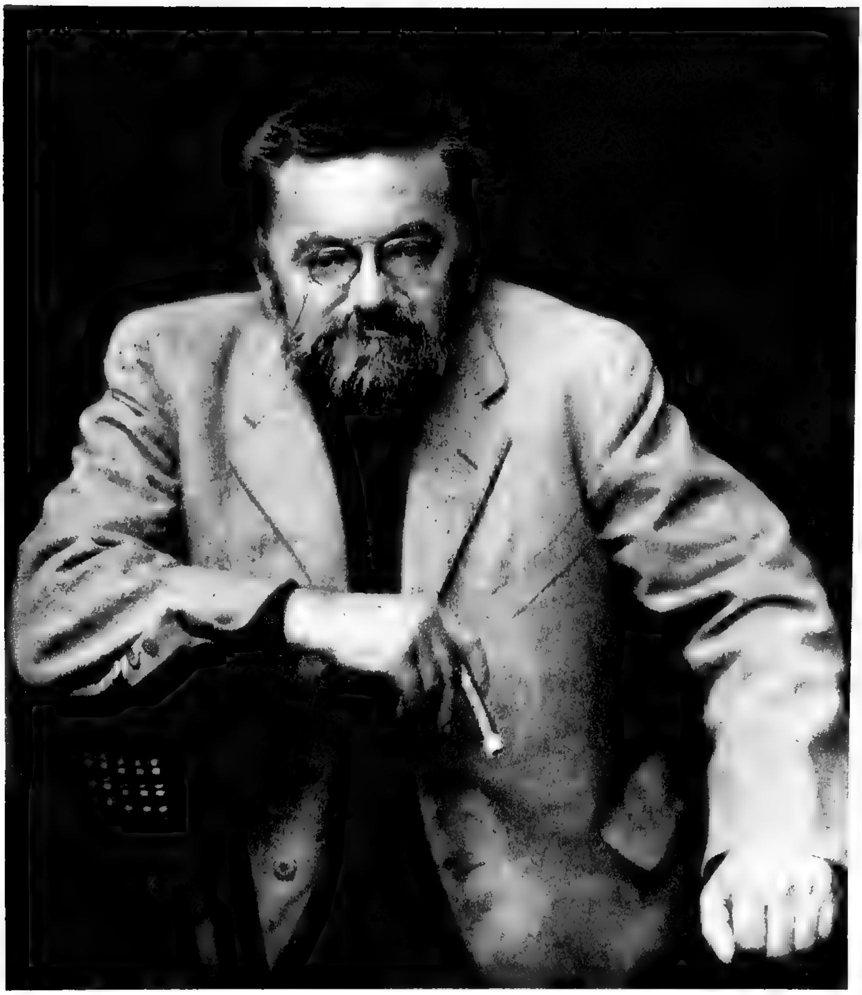
to awaken interest in better lighting. To this end he has written or supervised the preparation for publication purposes of a large amount of material on lighting practice. This has taken the form of company publications and articles and papers on illumination which have appeared at frequent intervals in the popular technical and trade journals. Mr. Stickney is of Puritan and Quaker ancestry and is eight generations removed from the original Stickneys who came from England to America in 1638. Mr. Stickney has served on many committees in different societies, whose functions dealt with work having a bearing on illumination. He is a member of the following technical and engineering societies: Illuminating Engineering Society, American Institute of Electrical Engineers (associate), National Electric Light Association, American Association for the Advancement of Science, Association of Iron and Steel Electrical Engineers, Association of Railway Electrical Engineers, American Museum of Safety, Engineers Club of New York. Prior to his election as president, he held the following offices in the Illuminating Engineering Society: Secretary (charter), New England Section, one year (1906); Chairman, New York Section, 1911 (two years); Chairman, Committee on Papers, 1914 (three years), and General Secretary, 1916 (one year).

THEODORE STEBBINS

When Theodore Stebbins chose the electrical profession in 1883 electricity had few commercial applications, other than the telegraph, and these applications were still great curiosities to the public and of unknown commercial value. He had personal relations with many pioneers, some famous, others now unknown, who laid the foundations of the present marvellous development.

Mr. Stebbins is a graduate of the Massachusetts Institute of Technology, a Fellow of the American Institute of Electrical Engineers, and Member of the American Society of Mechanical Engineers, of the Engineers' Club of New York, and of the Bankers' Club of America.

He was engaged with the General Electric and its predecessor companies from 1886 to 1903, and since has been occupied largely in public utility enterprises.



CHARLES P. STEINMETZ

CHARLES PROTEUS STEINMETZ

Dr. Steinmetz has been a source of inspiration to scientists and a source of salvation to many an engineer struggling vainly with some seemingly insuperable problem. There is little to tell to electrical engineers regarding his career—they all know him and rank him among the leaders of modern science; but, popularly speaking, his name is something of a vague abstraction. The explanation is simply that his work has gone over the heads of the crowd. Nothing sensational or spectacular marks the more than one hundred of his important electrical inventions, most of which affect the transmission of power and are understood only by the scientific world. The more ordinary of them include elevator motors and a mercury arc lamp.

As a young man, Germany became too hot for him because of his socialistic activities; he moved to Switzerland, but shortly came to the United States, landing in New York about twenty-six years ago penniless and unknown. For some time he was employed on mathematical work at Yonkers, N. Y., by Eickemeyer, a well known electrical inventor and pioneer in the development of the hat manufacturing industry. At that time he also began writing in English mathematical articles for the *Electrical World*. Since 1893 the General Electric Company have retained his services, it is said at a very large yearly salary, which, as one observer expressed it, "he gets for knowing more about electricity than any body else in the world." Up in Schenectady, where he has long lived in an environment of unusual but characteristic nature, he has been president of the Board of Education since 1912 and president of the Common Council since 1916, facts not cited as extraordinary honors but to illustrate the man's common touch with his fellow-mortals. Steinmetz thoroughly believes electricity to be an agency for the betterment of society. His ideals vision the eventual dispersal of our densely crowded city populations, a more even distribution over the land, where men will have a better chance for life, liberty and the pursuit of happiness, the amelioration of labor conditions and the abolishment of steam as a power medium. The Age of Steam drew people into cities; the Age of Electricity will draw them back into the country. Steam must be used where it is generated; electricity may be sent wherever it is needed. Steinmetz has translated his ideals into action, concentrating his inventive powers upon problems of long distance electric power transmission. His physical proportions are as apart from average standards as the rest of him. Only four feet in stature, he gives the impression of being all head and shoulders. The shaggy beard and keen eyes gleaming under the high, broad forehead, crowned with a mop of wiry, close cropped hair, suggest the mental counterpart of elemental physical strength. The brain within the huge head may be wondered at but not explained. In power of analysis it is abnormal. He is said upon one occasion when out in the open to have solved a difficult electrical problem mathematically and without exterior aid by the mental computation and application of a table of logarithms. He has reduced the rules of higher calculus, formerly used in figuring upon electrical laws, to terms in algebra, thus enabling young students to practice upon abstruse principles. Charles Proteus Steinmetz was born April 9th, 1865, at Breslau, Germany, the son of Carl Heinrich and Caroline (Neubert) Steinmetz. The "Proteus" was bestowed upon him by an early schoolmaster. Those acquainted with Greek mythology will understand the connection. His education in mathematics, chemistry and electrical engineering was had at Breslau, Berlin and Zurich. Years after, Harvard University conferred upon him the honorary A.M. degree, and the Union University of Schenectady, N. Y., where he has been professor of electro-physics since 1902, supplied the Ph.D. Dr. Steinmetz is the author of many written studies, articles, papers and books, embracing the results of significant, theoretical and experimental investigations. Dr. Steinmetz was president of the American Institute of Electrical Engineers, 1901-2. He is also a member of the Illuminating Engineering Society and the National Association of Corporation Schools.

Messrs. James R. Strong and Earnest McCleary and Their Work on Behalf of the National Association of Electrical Contractors and Dealers*

Throughout the work which Messrs. Strong and McCleary have done in connection with the National Association of Electrical Contractors, probably the task of remodelling the National Constitution to form the National Association of Electrical Contractors and Dealers stands out as the most important thing accomplished by these men, and it is probable that the movement started on the foundation thus established will be considered in years to come the important epoch in the history of retailing in the electrical industry. Realizing that the National Association in its old form was not sufficiently broad to cover the electrical retail industry the National Executive Committee last June directed that its Constitution Committee, consisting of the above named men, should associate themselves with Mr. W. L. Goodwin, and endeavor to work out a plan of broadening the scope of the association. This work was carried on during the summer of 1917, and in October of that year the plan involving a new constitution was adopted by the National Association of Electrical Contractors. Without going into all the details, suffice it to say that the plan broadens the scope of the old National Association, so as to include all retailers of electrical merchandise whether such electrical retailing is a minor or major part of their business, and it is hoped through an educational campaign carried on through this National organization that its members will be taught the proper principles of merchandising and how to do their business with due regard to cost, overhead, and a profit; that through the efforts of this organization in conjunction with other National organizations in the industry various wastes and duplication of effort will be eliminated so that the efficiency of all will be improved, making it possible to serve the American public and distribute electrical merchandise at less cost to the consumer and at a reasonable profit to all taking part in the transaction.

This National Association of Retailers does not contemplate and will not countenance any attempt at fixing prices or regulating channels of distribution, but will aim through its educational campaign to improve retail conditions and largely increase the number of points of contact which the public may have with electrical retailers.

The second important feature in the new Constitution is that by a system of graded dues the man doing a larger business shall pay his proportionate share towards supporting the National organization.

A study of the new Constitution shows a close connection between the National and its various subdivisions:

1. The four Division organizations, Atlantic, Central, Pacific, and Canadian.
2. The various State organizations forming the Division.
3. The various District organizations forming the State.

Eventually each of these subdivisions will be managed by an official secretary paid to carry on the work of the organization and collecting data and statistics for the use of the National organization, and acting as a direct connection between the individual and the National. Thus opportunity will be afforded to members in all parts of the country who cannot be away from their business for long periods to attend meetings in their own localities, and it is through this feature that it is expected that the campaign of education will be largely carried on. It is expected further that in these District meetings the other important elements of the electrical industry will meet with the contractors and dealers, with the view of solving in a broad way the problems of all, and thus eliminate many ills which have heretofore prevented the proper placing of the electrical industry before the public.

An important feature of the reorganization is that all meetings are open to the public and to any one interested.

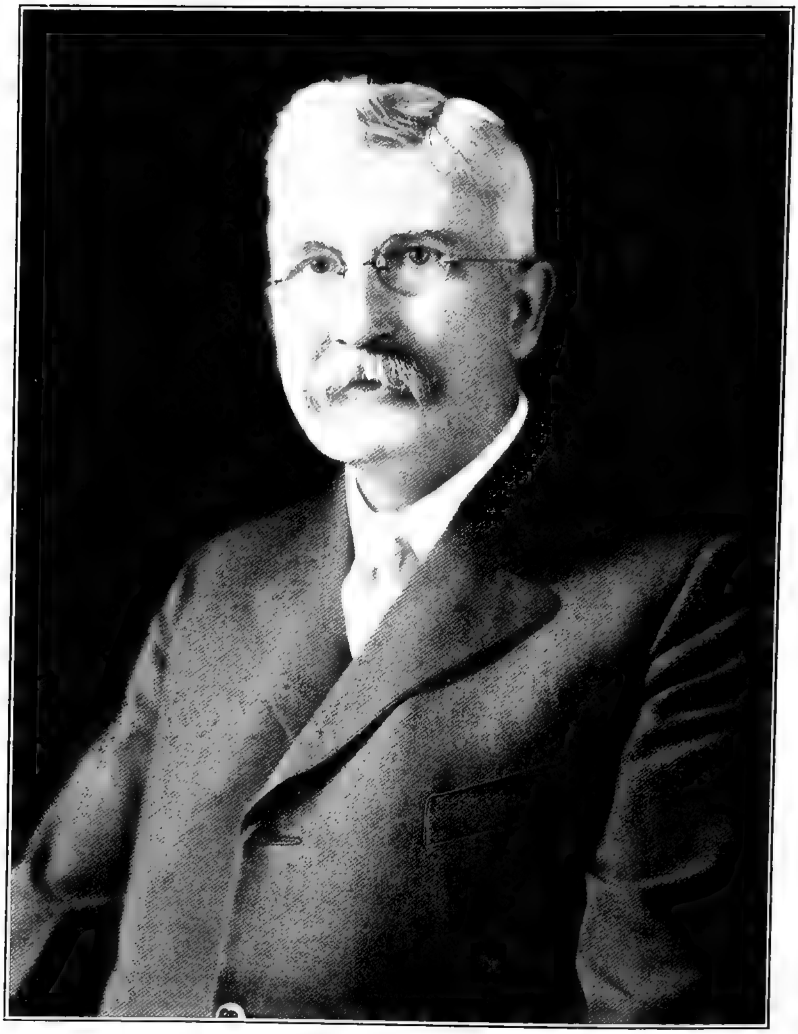
While both of the above named men had previously retired from office in the National Association, it is interesting to notice that Mr. McCleary is back in

*Further reference to this Association is made on page 330.

harness as Treasurer of the Association, and that Mr. Strong is retained in an advisory capacity, and that they are devoting their time to this new movement in the belief that it is a solution of most of the problems of the industry.

JAMES R. STRONG

James R. Strong was born in New York City, October 28, 1861, and graduated from Trinity College, Hartford, Conn., in 1882. He entered the electrical field by a practical course in the factories of the Watts-Campbell Corliss Engine Works and the United States Electric Lighting Company, in Newark, N. J., this association covering a period of four years. He was afterwards connected with the United States Illuminating Company in New York City, as Superintendent of the Construction Department for six years. Since 1890, he has been President of the Tucker Electrical Construction Company, New York City. Mr. Strong has been officially connected with the National Electrical Contractors Association since its inception in 1891, and was its President from 1905 until 1908.



EARNEST McCLEARY

Earnest McCleary was born in East Saginaw, Michigan, June 4, 1865, and was left an orphan at the age of twelve years. He served an apprenticeship at harness making, but ill-health compelled him to discontinue that trade, and he went on the lakes as a sailor before the mast, finally becoming first mate on a sailing vessel. In 1884, he entered the electrical field by starting with the Michigan Bell Telephone Company in their Construction Department, later going with the Edison Company of Detroit. In 1890, he entered the service of the Fontaine Crossing and Electrical Company, of Detroit, as Superintendent of Construction. In 1893, he transferred his activities to the Electric Supply and Engineering Company of Detroit, as estimator, becoming Superintendent of that company in 1896, and continuing in that position until engaging in business in 1900. He is now president of McCleary Harmon Company, of Detroit, Mich. Mr. McCleary's education was obtained by study out of working hours. He has been officially connected with the National Electrical Contractors' Association since its organization, in 1901, and was its president from 1903 until 1905.

FRANK M. TAIT

FRANK M. TAIT

Frank M. Tait was born in Catasauqua, Lehigh County, Pennsylvania. After leaving school he became a telegraph operator and assistant train dispatcher, afterwards taking the position of night engineer of the electric plant in the Catasauqua Rolling Mills. He next qualified as a stenographer and became secretary to the President of The Davies & Thomas Company of Catasauqua, and there acquired extensive experience as to the manufacture and use of structural iron and steel for tall buildings, street railways, gas works, tunnel work, general construction, etc.

In 1894 he began his central station career by becoming manager of the Catasauqua Electric Light and Power Company. Shortly afterwards he effected a consolidation of the local gas interests with the electric light company and directed the Catasauqua Gas and Electric Company until 1899. He then became connected with the public utilities of Somerville, New Jersey, and rebuilt all the plants and properties at Raritan, Somerville, Finderne and Bound Brook, New Jersey, merging them into the Somerset Lighting Company, which afterwards became and is now part of the Public Service Gas and Electric Corporation of New Jersey.

New London, Connecticut, was the next scene of his labors, where he became directing head of the gas and electric companies together with the management and operation of a general machine, boiler, coppersmiths' and boat repairing business, developing the corporation then known as the New London Gas and Electric Company, now a part of the Connecticut Company.

In 1905 he removed to Dayton, Ohio, to direct the affairs of the Dayton Electric Light Company.

While there the property was greatly enlarged into a corporation now well known as the Dayton Power and Light Company, and supplying electric light and power to upwards of 43 cities, towns and villages, and steam and hot water heating to several of the larger cities in the Dayton territory.

While in Ohio he was very prominently connected with the Ohio Electric Light Association, serving as its President in 1908.

The great Dayton flood occurred while Mr. Tait was located in Dayton, and he and his family were marooned on the second floor of their residence for three nights and four days, while the flood raged, and the rapid rehabilitation of the city after the flood was to a large extent facilitated by the tremendous work of his company and its staff.

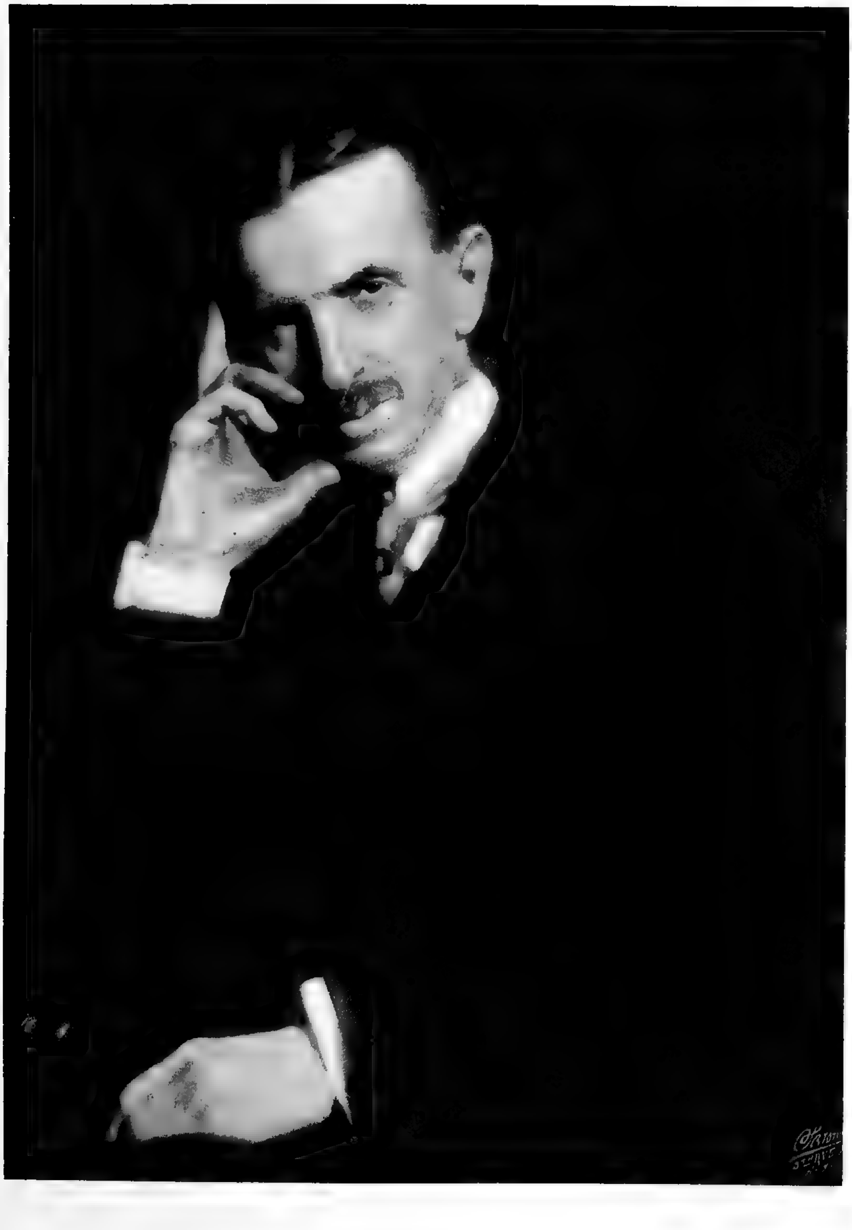
In 1915, Mr. Tait removed to New York City and became associated with the estate of A. N. Brady, at 54 Wall Street. He is a member of The National Electric Light Association, having served the association in years past as director, Secretary and Treasurer, Vice-President and President, in 1913.

He is also a member of the American Institute of Electrical Engineers, The American Gas Association, The Franklin Institute, Illuminating Engineering and other Societies. He maintains membership in the Engineers' Club of New York, Bankers' Club of America, Ohio Society of New York, The New York Squash Club, Engineers' Club of Dayton, and various other Dayton Clubs, and the Baltusrol Club of New Jersey.

NIKOLA TESLA

Manifestly the works of Nikola Tesla may not be stripped of their endless possibilities of scientific interest to conform to the limits of a brief article. As elsewhere in the biographical portion of our history, we simply take a side glance at the personality of the man—where he came from, the professional circumstances of his career, intimate incidents that have no place in a scientific treatise, with merely incidental reference to technical aspects. He who must know just what, when and where Nikola Tesla's accomplishments have been thus far has a tremendous field of study before him. In the most far-reaching effects of electrical science Tesla has had a hand; he gave solutions vital to the problems attending the harnessing of electric power to manifold industries. If his labors had comprehended only the invention of the polyphase alternating current system for the transmission of electrical energy, that alone would have stamped him as a great discoverer and benefactor. On the evening of May 18, 1917, in the auditorium of the United Engineering Societies Building, New York City, Bernard A. Behrend, addressing the American Institute of Electrical Engineers, spoke in glowing terms of the pre-eminent place held by Mr. Tesla in the regard of all who appreciate scientific achievement. The occasion was the presentation of the Edison Gold Medal of the American Institute of Electrical Engineers to the subject of the eulogy. Just twenty-one years prior to this date Tesla had stood before the same body and enunciated the principles of his rotating field induction motor so clearly and with such finality that nothing has remained to be said except by way of practical development. Here we give his words, spoken, remember, nearly a quarter of a century ago: "To obtain a rotary effort in these motors was the subject of long thought. In order to secure this result it was necessary to make such a disposition that while the poles of one element of the motor are shifted by the alternate currents of the source, the poles produced upon the other elements should always be maintained in the proper relation to the former, irrespective of the speed of the motor; but in a synchronous motor such as described, this condition is fulfilled only when the speed is normal. The object has been attained by placing within the ring a properly subdivided cylindrical iron core wound with several independent coils closed upon themselves. Two coils at right angles are sufficient, but a greater number may advantageously be employed. It results from this disposition that when the poles of the ring are shifted, currents are generated in the closed armature coils. These currents are the most intense at or near the points of the greatest density of the lines of force, and their effect is to produce poles upon the armature at right angles to those of the ring, at least theoretically so; and since this action is entirely independent of the speed—that is, as far as the location of the poles is concerned—a continuous pull is exerted upon the periphery of the armature. In many respects these motors are similar to the continuous current motors. If load is put on the speed, and also the resistance of the motor is diminished, more current is made to pass through the energizing coils, thus increasing the effort. Upon the load being taken off, the counter electromotive force increases and less current passes through the primary or energizing coils. Without any load the speed is very nearly equal to that of the shifting poles of the field magnet. It will be found that the rotary effort in these motors fully equals that of the continuous current motors. The effort seems to be greatest when both armature and field magnet are without any projections." The basis of the theory of operation leading to the creation of Tesla's rotating field induction motor was evolved by Prof. André Blondel of l'Ecole Nationale des Ponts et Chaussées of Paris and Prof. Kapp of Birmingham, England.

Tesla's system of power transmission had its first demonstration by Swiss engineers, at 30,000 volts from Lauffen to Frankfort. A few years later an adaptation of it on the grandest scale was made by the Cataract Construction Company at Niagara Falls, under the presidency of Edward D. Adams and with the aid of the Westinghouse Company's engineers. Tesla's influence may truly be said to have



NIKOLA TESLA

marked an epoch in the progress of electrical science. His mind has recognized no line of demarcation between the possible and the impossible. With the imagination of an artist and the will of a scientist he has blazed the path to the realization of new powers and resources, even though many of the forces of nature whose ways he has sought to unveil are still secret.

A rough list of Mr. Tesla's discoveries and inventions up to 1918 includes the following significant items: Two-phase, three-phase, multi-phase, poly-phase systems of power transmission, rotating magnetic field, rotating magnetic field transformer, induction motor, split-phase motor, system of distribution, rotary transformer, system of transformation by condenser discharges coil, oscillation transformer, electrical oscillator, mechanical oscillator, high frequency machines and coils, dynamo-electric oscillator, Tesla tube, lamp and Tesla high-potential methods, inductor, impedance phenomena, electro-therapy, electrical massage, arclight system, third brush regulation, steam turbine, gas turbine, water turbine, pump, compressor, igniter, condensers, electro-static field, Tesla effects, wireless system, methods of wireless transmission, magnifying transmitter, telautomata for warfare, insulation, underground transmission, etc. And this is not a complete list, either as to patents or practical working devices.

Various and many have been the actual consequences of Tesla's investigations during the past twenty years alone. They are of a nature that when stated in scientific terms—and they cannot otherwise be expressed—more than puzzles the untrained reader. But those who understand will recognize the purposes of Tesla's mechanical oscillators and generators of electrical oscillations (1895); researches and discoveries in radiation, material streams and emanations (1896-98); the high potential magnifying transmitter (1897); system of transmission of energy by refrigeration (1898); art of Tel-automatics (1898-99); discovery of stationary electrical waves in the earth (1899); burning of atmospheric nitrogen, and production of other electrical effects of transcending intensities (1899-1900); method and apparatus for magnifying feeble effects (1901-02); art of individualization (1902-03). Chronologically, the list might be extended both backward and forward. Tesla, as rumor has had it many times, has been working hard upon his system of world-telegraphy and telephony. Very little data, however, has been procurable that is descriptive of his later researches, and more is the pity from the historical standpoint. Fortunately a valuable record exists of Tesla's early discoveries and demonstrations. T. Commerford Martin was long a close observer of Tesla's work, and in 1893 published "The Inventions, Researches and Writings of Nikola Tesla," dealing in much detail with the inventor's great experiments up to that time and preserving his famous lectures delivered before the American Institute of Electrical Engineers in 1891, the Royal Institution of Electrical Engineers at London in 1892, and the Franklin Institute and National Electric Light Association at Philadelphia and St. Louis in 1893. These lectures were brilliant expositions of scientific truths; the speaker was accorded the most enthusiastic reception and his words produced a profound effect.

America may claim Tesla as her own, for he has long since legally adopted the country. He was born in 1857 at Smiljan, Lika, a borderland region of Austro-Hungary, of the Serbian race. His education was pursued through the Higher Realschule of Carstatt, Croatia, and the Polytechnic School at Gratz, where it was the young man's intention to prepare himself for a professorship in mathematics and physics. His brain was in too great a ferment to hold to such a narrow prospect, so instead he studied practical engineering. To Prague and Buda-Pesth he went to acquire languages that he might more broadly qualify himself for the electrical profession. For a while he served as assistant engineer in the Government Telegraph Engineering Department, improving the time by perfecting several telephonic details. Going to Paris, he became an electrical engineer in one of the large companies developing the new industry of electric lighting. Throughout these early years Tesla was continuously occupied with efforts to embody the rotating field principle in operative apparatus. Arrived in

America, Tesla's first day's move was to take off his coat in the Edison Works, the goal of his ambition. Though the necessity for working out his own ideas prevented his staying, he benefited by association with Edison and retained thereafter a strong admiration for him. There was then organized a company to make and sell the arc lighting system which he had labored diligently to perfect. That done, he devoted himself with renewed ardor to his old discovery of the rotating field principle for alternating current work. Another important discovery made in recent times by Tesla is that of a mechanical principle which he has succeeded in embodying in several types of machinery, such as reversible gas and steam turbines, pumps, air compressors, transformers and transmitters of power, etc. The principle aims at the production of prime movers developing ten h.p. or more for each pound of weight. Its application to aerial navigation and the propulsion of vessels makes very high speeds practicable. Tesla has not finished. The world waits expectantly for each fresh touch of his vitalizing thought upon the big electrical problems of the age. He is an extraordinary blend of such antipolar types as Faraday and Edison—and still unique with primal elements of his own.

MORRIS S. TOWSON

Morris S. Towson, Vice-President and General Manager of the Elwell-Parker Electric Company, is a native of Cleveland, of which city his parents were pioneers, and is of English descent. He was born June 4, 1865, was graduated B.S. and C.E. in 1886 from the Case School of Applied Science, Cleveland, and is a member of the Phi Kappa Psi fraternity.

MORRIS S. TOWSON

From 1887 to 1895 he was with Robert Gillham of Kansas City, Missouri, first as draftsman and later as engineer and associate. He was engineer of construction on elevated and cable railways in Kansas City, Denver, Omaha, Washington, D. C., Brooklyn, N. Y., and New York City. His work included designing and charge of construction of some of the finest cable railways built, including road work, power houses, machinery and all that goes to make up a complete cable railway system. But the advent of electricity into use for railway construction made cable railways obsolete, and in 1896 Mr. Towson went with The Brown Hoisting Machinery Company, of Cleveland, as engineer.

In 1897 he changed to The Elwell-Parker Electric Company, Cleveland, as engineer, later becoming factory superintendent, and in 1910 to his present position as Vice-President and General Manager, in which capacity he has done much work in the development and manufacture of electric vehicles.

He is a member of the American Institute of Electrical Engineers, the Cleveland Chamber of Commerce, Cleveland Athletic Club and the Society of Automotive Engineers.

FRANKLIN S. TERRY

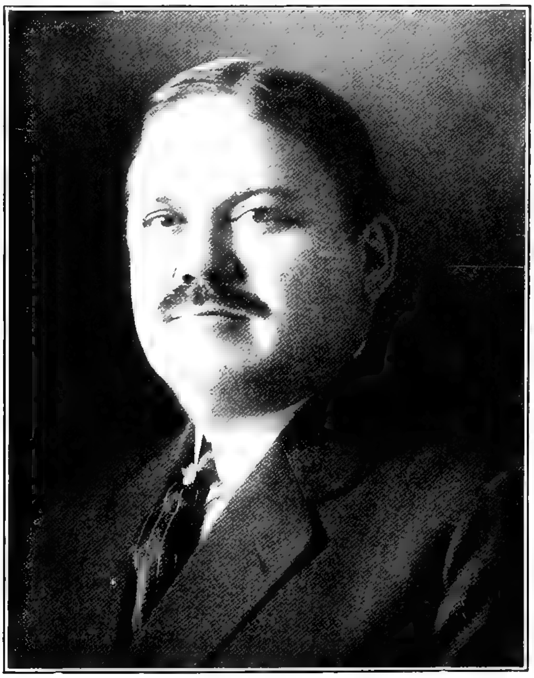
FRANKLIN S. TERRY

A pioneer in the incandescent lamp industry, whose activities have had much to do with the promotion of progress toward perfection in electric lighting, Franklin S. Terry is one of the notable men in the electrical field. He was born in Ansonia, Connecticut, May 8, 1862, was graduated from the Ansonia High School in 1880 and, after his graduation, began his active business career as a bookkeeper with the Electrical Supply Company of Ansonia, Connecticut, from April, 1880, to October, 1884. In the latter month he went to Chicago and established a branch of the same company, with which he continued until December, 1893. Meanwhile, in 1889, he had organized the Sunbeam Incandescent Lamp Company of Chicago, and when he left the Electrical Supply Company he took personal management of this lamp business, which, under his direction, progressed steadily. He saw the opportunities which opened up for the incandescent lamp with the ever-expanding adoption of electrical illumination and recognized that success in the lamp business would depend upon the ability to supply the ever-persistent demand for better light, and of various types and designs of lamps appropriate to the diversified needs of life and industry. He directed his energies toward improvement of the product and made his company one of the leaders in the lamp business, conducting it until May 1, 1901, when the Sunbeam Company was purchased by the National Electric Lamp Company, formed by J. B. Crouse, H. A. Tremaine, Franklin S. Terry, B. G. Tremaine and J. Robert Crouse, at that date. He engaged with the company, first as secretary and later as first vice-president. In 1911, the company was merged with the General Electric Company. Since then Mr. Terry has continued with the National Lamp Works of the General Electric Company, at Nela Park, Cleveland, Ohio, of which he and Mr. B. G. Tremaine are the managers. This ranks among the most widely known incandescent lamp enterprises in the world and employs the best engineering, designing and commercial talent for the production and sale of incandescent lamps. When Mr. Terry entered the lamp business he found a score of small, struggling companies, all bitterly competing and each jealous of what little progress its competitors, acting individually, might achieve. Today the lamp industry stands closely united in bonds of mutual acquaintance, harmony and coöperative effort, provided with every facility for improving lamp quality and leading in the race-old quest for better light. In this remarkable transformation, Mr. Terry has been a prime mover, his genius for organization making him a most effective factor in the bringing together of the various lamp interests. He was one of the organizers of the National Electric Light Association when that body was founded in February, 1885, at Chicago. For many years he has served on the Association's Incandescent Lamp Committee. In the management of his own enterprises, Mr. Terry has always sought, in every practical way, to increase the prosperity and happiness of his business associates and employees, and has devoted much personal attention to the development of a savings and investment plan to promote thrift. Under this plan an employee can start saving with as little as five cents. He has been active in French relief work, taking a personal interest in a large number of unfortunates whose distress resulted from the war. He has encouraged the formation of Red Cross classes in the lamp factories and vigorously promoted the Liberty Bond-raising and Red Cross campaigns. Outside of his business, Mr. Terry has an especial fondness for outdoor life, and finds his most favored times of recreation those when he is "out camping." He is one of the owners of a sixty-acre island in Lake Ontario, known as Association Island, where, in addition to its uses as a place of rest and recreation, many important electrical meetings are held during the summer months. He delights especially in beautiful landscapes and his fondness for artistic lawns, beautiful shrubbery and the freshness and attraction of natural ornamenta-

tion is shown by the splendid effects at Nela Park, where the National Lamp Works are located, and in other places where he has had a controlling voice in the improvement of the surroundings. His career has been marked by good judgment, the selection of congenial associations and competent subordinates, the constant forward movement in the enterprises under his control and the harmonizing of the interests of all connected with them. His social connections include membership in the Union League Club of Chicago and the Union Club of Cleveland.

CHARLES G. M. THOMAS

Charles G. M. Thomas, treasurer of the Consolidated Gas Company, has for years been greatly interested in the development of light and power companies throughout the country. He was born in New York City July 2, 1866, and, upon



CHARLES G. M. THOMAS

the completion of his education, entered the insurance business. His activity in the lighting field began in 1888 with the Standard Gas Light Co. of the City of New York, of which he became manager in 1893. During this period he was also President of the New Paltz & Walkill Valley Railroad and Vice-President and Treasurer of the Middletown, Goshen Traction Company. He was in succession vice-president and general manager of the Newtown and Flushing Gas Company and vice-president and general manager of the New York and Queens Gas Company and the Williamsport Gas Company. During this period he also served as vice-president and general manager of the Dallas (Texas) Gas Company, and in 1907 he became vice-president and general manager of the New York and Queens Electric Light and Power Company. He was made its president in 1913 and in 1916 was elected chairman of the board of directors of the company, which office he still occupies. Mr. Thomas is secretary and treasurer and a director of the Business Men's Land Company of Flushing, New York, and director of the Flushing National Bank. He is a member of the Merchants' Association of New York, past president and a director of the Chamber of Commerce of the Borough of Queens and chairman of the National Affairs Committee; a director of the Real Estate Exchange of Long Island.

He is connected with many scientific bodies, being a member and former president of the Empire State Gas and Electric Association and a member of the National Electric Light Association, the Society of Illuminating Engineers, the American Institute of Electrical Engineers, New York Electrical Society, the American Gas Institute, the Municipal Art Society, the National Geographic Society, a Fellow of the American Geographical Society, the American Numismatic Society, the Navy League of the United States and the Saint David's Society of New York, the Real Estate Association of the State of New York, National Tax Association, Queens Masonic Club, American Society of Political and Social Science, National

ELIHU THOMSON

Municipal League, National Security League, American Association for the Advancement of Science and the Real Estate Board of New York. He is also National Councillor to the Chamber of Commerce of the United States, was chairman of the Mayor's Committee on National Defense in Queens Borough, vice-president and director of the Councils of the Boy Scouts of America in the City of New York and vice-chairman of the Queens County War Aid Association.

Mr. Thomas is a Mason, being also a member of the Royal Arch and a Knight Templar, and a member of the Royal Arcanum. His clubs include the Niantic, the Flushing Country (past-pres.), Men's (past-president) and Third Ward Republican Clubs, of Flushing; the Long Island Automobile Club, and the Engineers' and Engineers' Golf Clubs, the Gas and Electric Golf Association (past-pres.), of New York; the Bayside Yacht Club, Engineers' Country Club, of which he is also president, and a member of the board of governors, and the Chamber of Commerce of the State of New York.

Mr. Thomas was married in New York City June 17, 1890, to Miss Saidee Antoinette Beach, and has had three children—Dorothy Gwen (died 1896), Marjory Beach and Charles Norton Thomas.

On January 27, 1916, Mr. Thomas was elected treasurer of the Consolidated Gas Company of New York, and in April of the same year he was made treasurer of the Astoria Light, Heat and Power Company, and Chairman of the Board of Directors of the New York and Queens Electric Light and Power Company, which three positions he still holds.

ELIHU THOMSON

Widely famed in technical and scientific circles for the great range and importance of his researches and achievements in the electrical field, and for his uniform friendliness and helpfulness to students, fellow workers and all those contending with the problems of electrical discovery, Dr. Elihu Thomson is in the foremost rank of those who have made ours preeminently the Electric Age, and has become one of the most revered and respected masters of electrical science.

He was born in Manchester, England, March 29, 1853. His father, Daniel Thomson, was Scotch, and his mother, Mary A. (Rhodes) Thomson, was English, but Professor Thomson is thoroughly and emphatically American. He came to this country with his parents, who settled in Philadelphia in 1858. He was graduated from the Central High School in 1870 with the degree of A.B., and received its A.M. degree in 1875. Late in 1870 he was appointed assistant professor of chemistry and in 1876 professor of chemistry, in the Central High School, holding that chair until his electrical researches constrained him to resign it in 1880. From the age of eleven he had been attracted by the phenomena of electricity, and he had made many electrical devices and instruments before taking the subject up in a professional way.

His first important invention was the three-coil arc dynamo which, with its automatic regulator and other novel features, formed the basis of the successful lighting system put out by the Thomson-Houston Electric Company, beginning in 1880. The three-coil dynamo was one of the first three-phase machines and was shown as an alternator in the original patent papers. His next step was the utilization of a magnetic field to control an electric arc, an idea since applied in many forms, but first used in connection with a lightning arrester for his arc system in 1881. Some of his earlier researches and inventions were made in collaboration with his former colleague in the High School, the late Professor E. J. Houston.

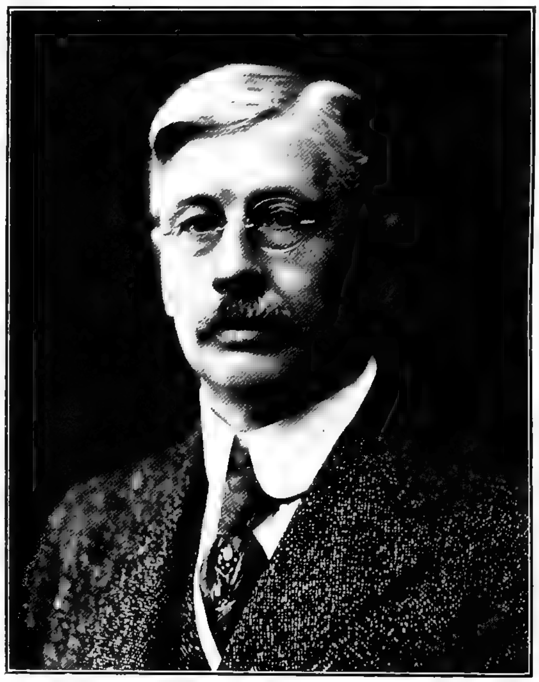
The Thomson-Houston Electric Company, established at Philadelphia in 1879, removed in 1880 to New Britain, Connecticut, and in 1883, when a Lynn syndicate bought control, the business was removed to Lynn, where, with more complete equipment, the Thomson-Houston enterprise was built up to great prominence. In 1892, by merger with the Edison General Elec-

tric Company, the General Electric Company was formed, now the largest enterprise of its kind in existence. During the pioneer years Professor Thomson was electrician and chief engineer, many of the fundamentally important inventions upon which the industry is based being his. Dr. Thomson is still actively engaged with the newer problems of the industry, being consulting engineer of the General Electric Co. and head of research laboratory work at the Lynn, Mass., plant. Many basic principles and inventions in connection with electric light, power and traction are his. He originated the art of electric welding by the resistance method which is now more and more applied in metal manufactures. The Thomson Electric Meter, first prize winner in a meter competition in Paris in 1890, is now used by millions. He pioneered in high frequency developments which later became the basis for wireless methods. His inventions touch all angles of electrical application, and his United States patents alone exceed six hundred.

Professor Thomson received honorary degrees of A.M. from Yale, 1890; Ph.D. from Tufts, 1894; and Sc.D. from Harvard, 1909. He has received from the French Government the decorations of Chevalier and Officer of the Legion of Honor. He was awarded the Rumford Medal, 1901; the Grand Prix at the Paris Expositions of 1889 and 1900; was the first recipient of the Edison Medal for electrical engineering, 1910; later received the Elliott Cresson Gold Medal from the Franklin Institute at Philadelphia, having before that twice received the John Scott Legacy Medal for electrical inventions. In 1916 he was the recipient of the John Fritz Medal, founded by the four great national engineering societies, which was awarded to him for his achievements in electrical invention, in electrical engineering, industrial development and scientific research. He is a member of the Corporation of the Massachusetts Institute of Technology, past president of the International Electrochemical Commission (1908-1911), and of the American Institute of Electrical Engineers; was United States delegate to the International Electrical Congresses at Chicago in 1893 and St. Louis, 1904, and was president of the Chamber of Delegates and of the Congress at St. Louis. He is a member of the National Academy of Sciences, Fellow of the American Association for the Advancement of Science (vice-president 1899); member of the American Physical Society, American Chemical Society, American Philosophical Society, Society for the Promotion of Engineering Education; Fellow of the American Academy of Arts and Sciences; honorary member of the British Institution of Electrical Engineers; member of the British Institution of Civil Engineers and of the Société Internationale des Electriciens.

WILLIAM STANTON TWINING

An engineer of especial prominence in connection with construction and operation of electric street railways, is William Stanton Twining, of Philadelphia. He



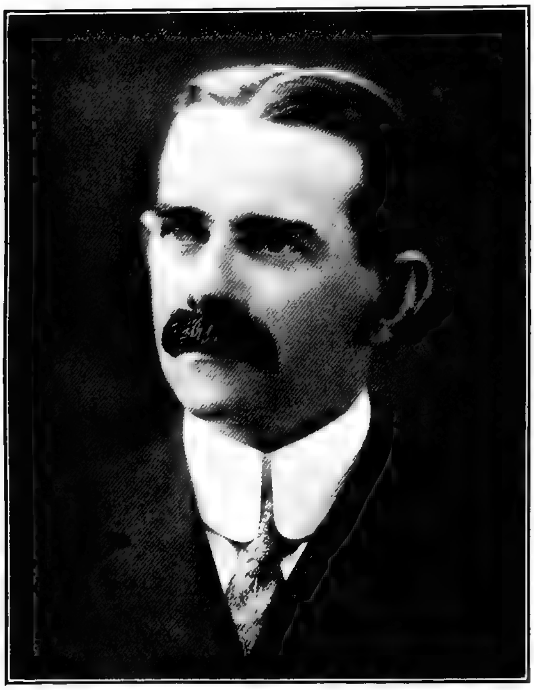
WILLIAM S. TWINING

was born near Titusville, Pa., February 20, 1865; attended Cornell University, 1884-1885, and Allegheny College, Meadville, Pa., 1885-1887, receiving degree of C.E. in 1887 and A.B. 1889; was instructor in Allegheny College, 1887-1890; went with the Thomson-Houston Company as assistant engineer in the Railway Engineering Department in its Boston office, 1890-

1891; assistant to Chief Engineer, Union Railway, New York City, 1891-1892; Atlantic Avenue Railroad, Brooklyn, 1892-1893; People's Traction Company, Philadelphia, 1893-1895; became Chief Engineer of the Union Traction Company, Philadelphia, 1895-1902, and of its successor, the Philadelphia Rapid Transit Company, 1902-1910, designing and constructing the first subway and elevated railroad line in Philadelphia (on Market street), 1902-1908. He was Engineering Manager for Ford, Bacon & Davis, New York, 1910-1916, until appointed February 15, 1916, by Mayor Smith, as Director of the Department of City Transit of the City of Philadelphia. In that capacity he has charge of design and construction of the city's system of Rapid Transit lines, covering about ninety miles of track, as now authorized, and estimated to cost about $80,000,000 for construction and $20,000,000 or more for its equipment.

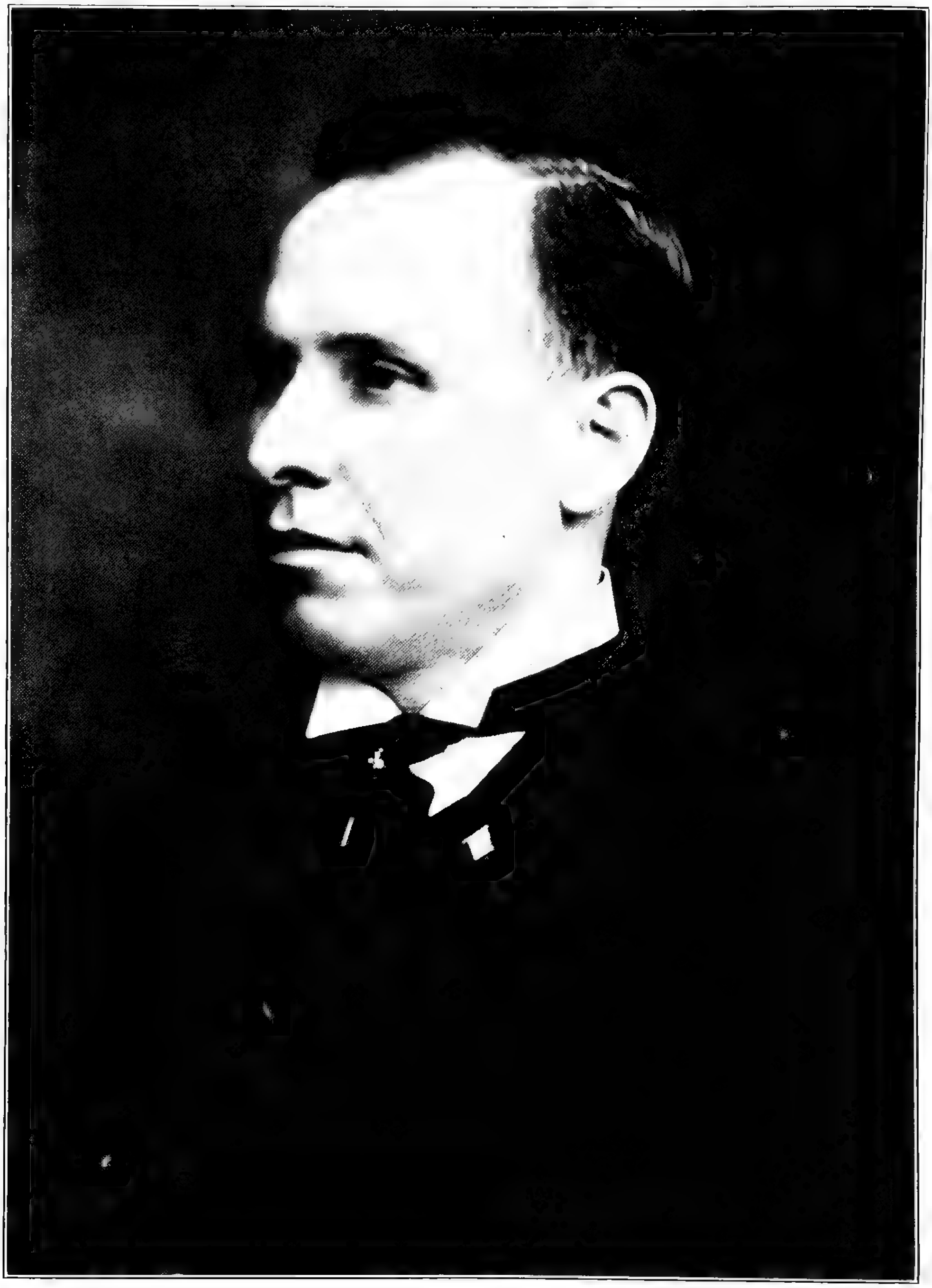
He is a member of the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, Franklin Institute, and the Engineers, University, and Manufacturers clubs of Philadelphia.

THOMAS E. TYNES



THOMAS E. TYNES

For the past ten years Thomas E. Tynes has been engaged upon the numerous tasks of electrical engineering practice applied to steel production in the plant of the Lackawanna Steel Company, Lackawanna, New York. He completed a special course in Electrical Engineering in the University of Nebraska in 1896, entering business the following year in Chicago in a manufactory of scientific instruments. Very soon after he was superintending the installation of electric equipment for interurban railways in the middle west for the Westinghouse Electric and Manufacturing Company of Pittsburgh, Pa., being with them for eight years. The lines for which he performed such service included the Indiana Union Traction System and the Union City, Winchester and Muncie systems; also those of the Muncie & Portland, Western Ohio Railways, and the Ft. Wayne & Wabash Valley Traction Co. Mr. Tynes is of English ancestry; a descendant on his mother's side of the English historian, Sir John Evelyn, and on his father's side of noted sea captains in the British Colonial Service.



ALEXANDER H. TRUMBULL
President of the Connecticut Electric Manufacturing Company
(See following page)

ALEXANDER H. TRUMBULL

Alexander H. Trumbull, president of the Connecticut Electric Manufacturing Company, Bridgeport, Conn., has, in his position as directing head of that organization, built up one of the greatest industrial plants in New England, the output of which consists of electric fittings for homes, offices and business buildings of all kinds. The Connecticut Electric Manufacturing Company was originally established at Bantam, Conn., by Mr. Trumbull in association with his brothers, Isaac B. and James Trumbull. The business was a success from its inception and Mr. Trumbull soon became obsessed with the idea that the limitations of Bantam were too narrow and that a larger city would afford opportunity for increased trade and broader expansion. Acting upon this conviction the business was removed to Bridgeport, Conn., in 1912, where the company, in anticipation of the removal, had erected a factory at Connecticut and Florence Avenues. This structure is 60x150 feet and is three and one-half stories high. It is of mill construction, thoroughly equipped with all modern machinery and appliances. Its well-lighted and sanitary interior, amply protected from fire, shelters 300 employees, of which fifty per cent are girls. The output is distributed all over the United States and South America and the export trade, which has largely increased in the past four years, spreads out to most of the trade centers of Europe, Asia and Africa. When the business was first removed to Bridgeport, Alexander H. Trumbull filled, as he does now, the position of president, James Trumbull was vice-president and Isaac B. Trumbull acted as secretary and treasurer. Isaac B. Trumbull, whose portrait is shown on the next page, was lost on the Lusitania in May, 1915, and James died in April, 1916, leaving Alexander H. Trumbull in sole charge of the business, which has largely increased under his careful management. Mr. Trumbull, the only survivor of the original organization, was born on October 12, 1876, in West Hartford, Conn., the son of Hugh H. and Mary Ann (Harpen) Trumbull. The family, originally Scotch, went to Ireland to escape religious persecution, and the father was born in Ulster, noted for its robust men of progressiveness and determination. After coming to this country they resided in several Connecticut towns and finally removed to Plainville during Alexander Trumbull's boyhood, and he was educated there. He had six brothers, all of whom entered the manufacturing business, and when Mr. Trumbull finished his schooling he was employed by the Trumbull Electric Manufacturing Company, which was organized by two of his brothers, John H. and Henry Trumbull. Later he engaged in electrical construction, and with his knowledge of the electrical industry he launched the venture at Bantam, which has met with more than ordinary success, and placed its directing head in the front rank of New England manufacturers of electrical appliances. When he organized the company Mr. Trumbull had a capital of $800. Upon incorporation the company was capitalized at $25,000, of which $8,000 was paid in. It is now $200,000, all paid, and the business in 1916 amounted to $1,250,000. This remarkable growth is undoubtedly due to Mr. Trumbull's able management, his knowledge of electrical conditions and an ability to extend the export trade to profitable centers. The company now employs three traveling salesmen who operate from the factory, and many more from the New York City office at 30 Church Street. In addition to this system of distributing the product, offices are maintained in Chicago and San Francisco.

Mr. Trumbull was married December 6, 1906, to Mary Smith of Litchfield, and there are two children, Marion and Donald Smith Trumbull.

He is a member of the Algonquin Club, the Housatonic Rod and Gun Club and the Weatogue Club.

THE LATE ISAAC B. TRUMBULL
One of the three Trumbull Brothers who founded the Connecticut Electric Manufacturing Company.
(See preceding page.)

BOWEN TUFTS

BOWEN TUFTS

Bowen Tufts, one of Boston's leading bankers, has spent practically his entire business life in the development of the bonding business of C. D. Parker & Co., Inc., and their predecessors who have always specialized in New England municipal, real estate and public utility securities and in the development of New England's public utilities. He is now interested in over a score of electric railway, light, heat and power companies scattered throughout the down-east territory. Mr. Tufts was born in Lexington, Mass., June 17, 1884, and his New England origin is attested by his direct descent from Peter Tufts, who arrived in America about 1675 and settled in New England. Mr. Tufts was educated in the grammar and high schools of Somerville, Mass., and upon the completion of his studies he obtained a position with the banking house of Jose, Parker & Co. This was in 1899, and four years later he became manager of the firm. His quick grasp of financial affairs and the intricacies of investment securities brought rapid advancement, and in 1910 he was made a member of the firm of C. D. Parker & Co., which succeeded to the business of Jose, Parker & Co. In 1912 the business was incorporated under the name of C. D. Parker & Co., Inc., and Mr. Tufts became vice-president and manager of the vast business of the house, which, in addition to general banking, includes the management and financing of public utility and other companies. Mr. Tufts' interests are many and varied. He is Vice-President, Manager and Director of C. D. Parker & Company, Inc., bankers, and Vice-President and Director of the following companies: Amesbury Electric Light Company, Athol Gas & Electric Company, Blackstone Electric Light Company, Central Massachusetts Electric Company, Gardner Gas, Fuel & Light Company, Great Barrington Electric Light Co., The Lenox Electric Company, Marlboro Electric Company, Marlboro-Hudson Gas Company, Merrimac Valley Power & Buildings Co., North Brookfield Electric Light & Power Co., Norton Power & Electric Company, Norwood Gas Company, Plymouth Gas Light Company, Provincetown Light & Power Company, Randolph & Holbrook Power & Electric Co., Southeastern Massachusetts Power & Electric Co., Stockbridge Lighting Company, Union Light & Power Company, Ware Electric Company, Westborough Gas & Electric Company, Weymouth Light & Power Company, Winchendon Electric Light & Power Company, Worcester Suburban Electric Company. He is also a Director of the following companies: Concord, Maynard & Hudson Street Railway, Connecticut Valley Street Railway, Gas & Electric Improvement Company, Massachusetts Real Estate Exchange, Plymouth Electric Light Company, Weymouth Water Power Company, and a Trustee of the following: Belmont Springs Trust, Commonwealth Gas & Electric Companies, Central Massachusetts Power Company, Franklin County Power Co. (also Vice-President), Lynn Realty Trust, Massachusetts Consolidated Railways, Massachusetts Lighting Companies, Merrifield Buildings Trust (Worcester), Old Colony Light & Power Associates, Parker Building Trust, and is the Treasurer and a member of the executive committee of the National Electric Light Association (N. E. Div.). It will be seen by these various interests that Mr. Tufts has been one of the most active men in the development of New England's electrical industry and bids fair to eventually extend his activities beyond New England's boundaries. Mr. Tufts was married September 23, 1907, to Octavia E. Williams, of Chicago. The children by the union are Mary Octavia, Bowen Charlton and David Albert. Mr. Tufts resides at Winchester, Mass., and his offices are at 78 Devonshire Street, Boston, where as Vice-President and manager of the C. D. Parker & Co., Inc., he devotes his time to the company's business and the affairs of the house, which has become one of the leading concerns in its line in the New England metropolis.

FRANCIS ROBBINS UPTON

The basis of Thomas A. Edison's productive researches and revolutionary inventions has been a finely organized company of experts whose operations have been carried on with all the efficient method and attention to detail associated

FRANCIS R. UPTON
From a photograph taken in 1889

with great commercial organizations. Huge sums of money were spent, countless hours consumed in close laboratory work, and explorers sent to remote parts of the world on the mission of discovering some rare element, before the Edison carbon filament lamp was evolved. Francis Robbins Upton is entitled to the credit implied in having been a coadjutor of Mr. Edison, on which account he is spoken of wherever the "wizard's" achievements are known. He arrived at Menlo Park in 1878, bringing the zeal of one bent upon their first free adventure and the avowed desire of becoming a disciple of Edison. From Peabody, Mass., where he was born, July 26, 1852, he went to Phillips Academy at Andover, Mass., to Chauncey Hall, Boston, and to Bowdoin College, taking the Bachelor of Science degree at the latter institution in 1877. The ensuing three years were spent at Princeton College, where a degree was granted him in 1877, and at the University of Berlin. As a college student, he specialized in mathematics and physics, entering Edison's employ in the capacity of mathematician. But his usefulness was not circumscribed by any narrow definition of grade; on the contrary, he ably conducted much of the important early work of the Edison laboratories. There developed, for instance, his mathematical analysis of the multiple arc feeder and three wire system of electric lighting. He performed many important experiments bearing upon the incandescent carbon filament; lighting a No. 2 high resistance lamp beside a No. 1 and observing that No. 1 did not flicker; being the first to raise carbon filaments to a higher point of incandescence when they were being exhausted than they would be subjected to at normal candle power. He designed the present Edison base on incandescent lamps, sending the gauges out to the world; he took charge of Edison's search for fibres; he was commissioned to buy the first parcel of land for the Edison Illuminating Co. of Boston. In fact, Mr. Upton's interests have been for years synonymous with the name of Edison. He is a former director of the Edison Electric Lighting Co., the Edison Illuminating Co. of New York, the Edison Company of Isolated Lighting, the Edison Lamp Co., and the Edison Portland Cement Co. He had charge of the first incandescent lamp factory, was formerly general manager of the Edison Lamp Works, and vice-president of the Edison Electrical Engineers. One of his best deserved distinctions is, perhaps, that of being president of the Edison Pioneers. More recently Mr. Upton has been the sales manager of the National Tube Works of Pittsburgh, with offices in the Union Building, Newark, N. J.

CHARLES R. UNDERHILL

CHARLES REGINALD UNDERHILL

Captain Charles Reginald Underhill, electrical engineer, inventor, author, lecturer and specialist in the application of electromagnets to numerous industrial purposes, was born in Chappaqua, New York, November 2, 1874. He is a direct descendant of Captain John Underhill, of Colonial fame. On account of deafness in his youth he did not attend college, and he is largely self-educated, and from boyhood has always been much interested in problems of physics and electricity. He was employed in the inspection department of the Western Electric Company in New York from 1892 to 1900, becoming assistant chief inspector during that time. He became chief electrical engineer of the Varley Duplex Magnet Company, Jersey City, N. J., and Providence, R. I., from 1900 to 1904. It was during this connection that he acquired a special interest in the subject of electromagnets, it being his duty to design them for numerous and widely different purposes. The very small amount of data at that time available in regard to electromagnets compelled him to enter upon investigations of his own, which he has continued for the past seventeen years, and his laboratory force is continually testing electromagnets in various applications under his direction. He was engaged in general practice as a consulting electrical engineer in New York City from 1904 to 1909, then was engaged for a few months as an editor and technical writer with the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pennsylvania, resigning to become chief engineer of the American Electric Fuse Company, 1910 and 1911, at Muskegon, Michigan. On July 1, 1911, he became the chief electrical engineer for the Acme Wire Company, of New Haven, Connecticut, manufacturers of magnet wires, electromagnets, coil windings of all kinds and standards and special wires for electrical purposes and recognized as leaders in those especial lines in which quality and accurate gauging are of the highest importance; and this business has increased to large and international scope. Captain Underhill has made deep researches into the aspects of electromagnet design and operation. He discovered and published general laws for the predetermination of the mechanical force characteristics of electromagnets for operation on either continuous or alternating current circuits, and he has designed great numbers of electromagnets for numerous purposes. Besides these researches in his specialty of electromagnets, he has devoted much attention to general electrical phenomena from the scientific side and especially in connection with the application of the Electron Theory to the phenomenon of electrical resistance. He has lectured on "Electromagnets" at the principal colleges in the United States, including the University of California and the Leland Stanford, Junior, University in California. He successfully placed in electrical and mechanical operation the Cobb automatic shockless railway crossing, in Los Angeles, California. Captain Underhill is inventor and patentee of several types of electromagnetic coils, processes and machines for producing such coils. He is author of "The Electromagnet," in 1903; "Wireless Telegraphy and Telephony" (with W. W. Massie), 1908; "Solenoids, Electromagnets and Electromagnetic Windings" in 1910; "Magnets, Induction Coils, and Condensers," Section 5 of the Standard Handbook for Electrical Engineers, 1915; and has written many articles and papers published in important electrical publications and in the transactions and proceedings of engineering societies. In his specialties he is regarded as a leading authority, and his researches and inventions have added much to the efficiency and increased the applications of electromagnets to various purposes. In 1905 he became much interested in the problems of wireless telegraphy and telephony, and devoted considerable attention and experiment to the subject. He invented, patented and demonstrated a machine for printing "wireless" Morse or Continental Code messages in plain English characters on tape like a stock-ticker and demonstrated the device to William Marconi, Nikola Tesla, Dr. Lee de Forest, and

many other notable "wireless" men; and he demonstrated the machine at sea as well as on land. As the result of much other electrical experiment he was at the time of his entering the service bringing out new signaling apparatus, and other electrical apparatus for use in connection with automobiles. He has applied electromagnets to a large number of mechanical devices and has attained recognition as a leader in that work. In December, 1917, he was appointed Captain in the Aviation Section of the Signal Reserve Corps, U. S. Army, and entered active service on January 14, 1918. He was released from service on January 8, 1919, and returned to the Acme Wire Co. as chief electrical engineer. He is a Fellow of the American Institute of Electrical Engineers; Member of the American Society of Mechanical Engineers, American Association for the Advancement of Science, associate member of the Society of Automotive Engineers, Institution of Radio Engineers, and American Physical Society. He is also a member of the Engineers' Club of New York, and of the Quinnipiack Club of New Haven, Connecticut, and the United Service Club of America, of Washington, D. C.

CHARLES JOSEPH VAN DEPOELE

The application of electricity to street railway traction forms a very important item in the story of electrical development. Street railways are an American development, and were all run by horse and mule power until a few cities adopted the cable method, which doubtless would have spread to many other places had it not been for the timely invention of the electric trolley system by Charles Joseph Van Depoele, who lives in electrical history as the "Father of the Trolley System." He lived to put it on a firm and substantial footing, but died before he had received the larger reward and the full recognition that belongs to one who had done so much for the advancement of electrical science. Mr. Van Depoele was born April 27, 1846, in Lichtervelde, Belgium. The family name was van de Poele, and thus spelled indicated a title, but he changed it to the form Van Depoele, as he was democratic in his ideas. His ancestors lived in and around Bruges. He was educated at the College of Poperinghe, Belgium, and the Imperial Lyceum, Lille, France. His father, Peter Van Depoele, was for several years master mechanic of the East Flanders railway shops at Poperinghe. Young Van Depoele, brought up with mechanical surroundings, found deepest interest in machinery and especially in some batteries and other electrical apparatus that formed part of the equipment of the railway shop. He wanted to know more about such things, and while he was a student at the local college in Poperinghe, he not only kept up with the studies of the regular curriculum, but bought books and took private studies in physics, mechanics and electricity, and when only fifteen years old had succeeded, through the use of about forty Bunsen cells, in generating his first electric light. The boy's father regarded his son's experimental work as a waste of time and the pursuit of useless knowledge, so that Charles did most of his research while his father was away, but parental solicitude that the boy should learn a real trade led to his being apprenticed to a Paris wood-carver, who made church furniture, altars and reredoses. The family moved to Lille, and the young man took a special course in physics, and particularly in electricity, in the Imperial Lyceum. His enthusiasm for these branches of study was so great that it attracted the attention of Dr. Patoir and other members of the faculty of the institution. But the father's attitude towards the son's desire to experiment with electricity was still unfavorable, so the young man, in 1868, went quietly away from home, visited an aunt at Antwerp for two weeks, and then set sail for the United States, locating in Detroit. He did not start an electrical enterprise at first. His initial business venture was along the line of least resistance. He knew the church furniture business, and with a compatriot, Joseph Artz, he started a manufactory in that line which had much success, at times employing as many as two hundred operatives. He continued in that business until 1877. His parents had joined him not long after his arrival in Detroit,

CHARLES J. VAN DEPOELE
(DECEASED)

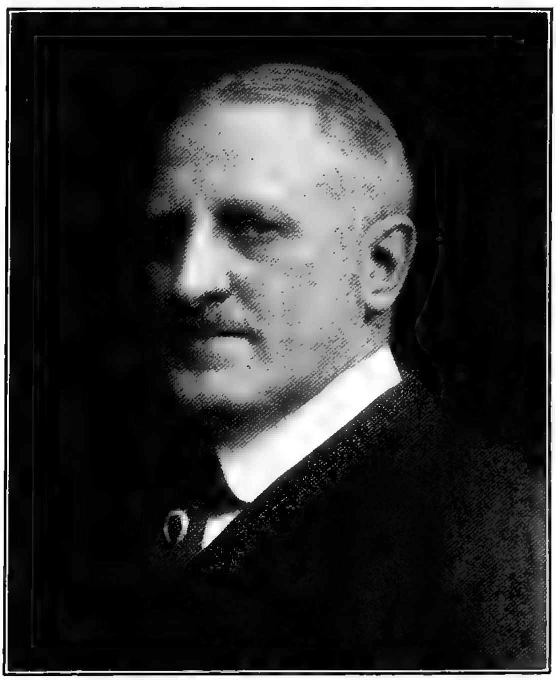
and in 1870 he married Miss Mina van Hoogstraten. While in the church furniture business Mr. Van Depoele had continued his electrical studies. He completed various inventions, but found capital shy about investing money in their exploitation. With money earned in his furniture business, he constructed a battery of 100 Bunsen cells with which he operated electric lights. In 1877 he turned over the furniture business to his father, constructed a laboratory, and devoted his attention entirely to electric problems. He constructed a dynamo broadly based upon the one which Gramme, by a combination of the continuous current principle of Pacinotti's dynamo with the self-excitation of field magnets of Wheatstone, Varley, Siemens, Ladd and Farmer, had formulated into the first commercially practical continuous current dynamo. The one which Mr. Van Depoele made he greatly improved, and he soon evolved a type of dynamos far in advance of any other then in vogue. He devoted much study to the problem of arc lighting, and in 1877, when he installed an arc light above his laboratory, it glared so luridly through an overhanging fog that a nervous citizen turned in a fire alarm under the impression that some building was on fire. In 1878, when Forepaugh's Circus visited Detroit, the illumination of the grounds in which the circus tent was pitched formed a noteworthy added attraction for the visitors, and soon after when Recreation Park was lighted by Van Depoele lamps, the demonstration was so satisfactory that Mr. Van Depoele was able to secure many lighting contracts and to organize in 1880 the Van Depoele Electric Light Company, with new shops at Hamtranck, a suburb of Detroit. An important business was done in dynamos, motors and other apparatus. In 1880 the enterprise was removed to Chicago and reorganized in 1883, with Albert Wahl and A. K. Stiles of Chicago as investors, the company being named the Van Depoele Electrical Manufacturing Company. In 1882, the Van Depoele Electric Light Company made arrangement with some interested parties to put up a plant for exhibition with a view to test the availability of electric propulsion for the then projected elevated railway at Chicago. Some delays prevented the completion of the preparations for the test until February, 1883. The track, which was 500 feet in length with a 5 per cent grade toward the centre of its length, was temporarily equipped, and a car, accommodating twenty-five people, was kept busy for several weeks with perfect success. In the summer a temporary elevated track was built on the roads of the Chicago Inter-State Fair, opened September 10, 1883, and for the fifty days the fair was open the car on this track was busy carrying people around the grounds without a hitch. A similar installation and exhibition on the grounds of the Toronto Annual Exhibition was made, but with an underground conduit instead of an overhead wire, and this led to an order to construct a one-track road a mile in length, with overhead wire, for the Toronto Industrial Exposition in 1885, connecting the street cars with the exposition grounds. Orders came for the installation of electric railways in New Orleans and Minneapolis, in 1885; Montgomery, Ala., Appleton, Wis. (first complete road), Port Huron, Mich., Detroit, Mich., and Windsor, Ont., 1886; Wheeling, W. Va., Lima, Ohio, Scranton, Pa., Binghamton, N. Y., and Ansonia, Conn., in 1887; Dayton, Ohio, in 1888, and Cincinnati, Ohio, in 1889.

There have been many patents and improvements in electric railways since Mr. Van Depoele's day, but his idea of the little wheel on the trolley pole running under the overhead wire still survives as the most economical and efficient running contact for electric railroads so situated as to make the mode of propulsion available. So the designation of Mr. Van Depoele as the "Father of the Trolley" is fully deserved. Mr. Van Depoele removed to Lynn, Mass., about 1890, and remained with the Thomson-Houston Company and the General Electric Company, its successor, until his death at Lynn, Mass., on March 18, 1892. He had been doing experimental work on electric mining machinery during the period immediately previous to his last illness, and also on some new developments in electric lighting which he expected to be his crowning achievement, but of which the secret died with him. His place as a pioneer in the electric railway art has been fully sustained by the United States Courts, but the railway work was by no means his sole contribution to the electric industry. His basic

work on electric power in the improvement of dynamos and motors was highly valuable, and his invention of the carbon brush, in the fall of 1888, brought a revolution of the efficiency of car motors and electric motors of every kind. There was an appalling expense attached to the use of the old-style metal brushes, which wore out commutators with remarkable rapidity. Professor Elihu Thomson tells how at a conference in Lynn, the question of this destruction of commutators came up, and Mr. Van Depoele suggested the use of the carbon brush which he had invented in Chicago. The test was made and proved so satisfactory that the General Electric Company finally adopted the carbon brush for use on both dynamos and motors. The wear on commutators was thereby reduced to inconsiderable proportions, the reversals and shiftings required with the copper brushes were entirely eliminated and the saving in expense was as great as the increase in efficiency. Nearly two hundred and fifty patents were issued by the United States to Mr. Van Depoele during his fifteen years of research and experiment. They touch almost every phase of electrical application, and their wide range bears eloquent testimony to the depth of knowledge and breadth of vision of this world's pioneer electric railway man. His patent rights were sold to the General Electric Company about three years after his death at a time when his family was abroad. He was a member of the American Institute of Electrical Engineers and the National Electric Light Association. He combined an engaging personality with great genius and an optimistic outlook upon the possibilities of electrical progress.

HERBERT HAROLD VREELAND

H. H. Vreeland's achievement along steam and electric surface railway lines



HERBERT H. VREELAND

shows that merit alone wins. Mr. Vreeland was born in Glen, N. Y., October 29, 1856, and in 1875 was employed as a gravel shoveller on the Long Island Railroad. He rose to the position of conductor, and filled a like position with the New York & Northern Railroad, of which he afterwards became general manager. Following this connection he was made president and general manager of the Metropolitan Traction Company, rising in eight years from a subordinate position to the direction of the greatest system of surface electric roads in the world. He developed the change of motive power of the company's lines from horse to cable, and subsequently electrified them. As president he took a vigorous stand against the system of political appointments then in vogue and gave personal interviews to all employees with grievances. This action resulted in the discontinuance of strikes and better service to the public. Mr. Vreeland is interested in various financial and commercial corporations and is vice-president of Interborough Consolidated Corporation and a director in a dozen transportation companies. He was first Chairman of Welfare of the National Civic Federation, chairman of the executive committee of the New York Railroad Club, and is a member of many clubs and societies. His offices are at 165 Broadway, N. Y. City.

FLOYD L. VANDERPOEL

FLOYD L. VANDERPOEL

In a history of electricity, from the days of Franklin, up to the time of the commercialization of the mysterious force, and the subsequent development which has made it the world's leading industry, credit must be given to those men who have, either by research and investigation, or by manufacturing and exploiting the many inventions and discoveries, aided in the stupendous growth of the industry. Among those prominent in electrical manufacturing is Floyd L. Vanderpoel, president of the Trumbull-Vanderpoel Electric Manufacturing Company, of Bantam, Conn. Mr. Vanderpoel was born in Saugerties, N. Y., October 16, 1891, the son of John A. and Elizabeth (Battelle) Vanderpoel. The first Vanderpoel to come to this country located in Albany, N. Y., in 1651, the family later moved to New York City. Mr. Vanderpoel's great-great-great-grandfather was Benjamin Tallmadge, Colonel in the Continental Army, and a great friend of General Washington. Colonel Tallmadge moved to Litchfield, Connecticut, from Long Island shortly after the nation's first conflict at arms, and resided there until his death, Colonel Tallmadge's homestead being one of the show-places of the town. Mr. Vanderpoel received a preparatory education in England and at the Choate School, Wallingford, Conn. He subsequently took courses in chemistry and physics at Columbia University, and then turned his attention to experimental work along electrical lines. He had a natural taste for mechanics, and in 1912, when only 21 years of age, organized the present company in connection with George Trumbull. Upon the establishment of the business, a small building was purchased in Bantam and converted to the uses of the company by the installation of all necessary machinery. This plant was completely destroyed by fire February 19, 1913. Preparations for the erection of the present factory building were immediately commenced, and it was erected in record time. It is 40 x 80 feet, and four stories high. The growth of the business soon necessitated more room and a four-story addition, 25 x 30 feet, was built, giving a total floor space of 15,800 feet. As this goes to press the company is erecting another four-story building which will give them 12,800 more feet of floor space, which is necessitated by the volume of business. The buildings were constructed along the most approved sanitary lines, particular attention being paid to light and ventilation and the installation of a complete sprinkler system for fire protection. The equipment consists of the latest machinery and everything used throughout the factory is the most efficient that could be bought. One hundred people are employed, and the product consists of switches, switchboards, panel boards, fuses, fuse blocks, weatherproof sockets, steel and wood cabinets, special attention being paid to the manufacture of the Trumbull-Vanderpoel Patented Quick Break Switch, the invention of Ralph K. Mason, vice-president and general manager of the company. The switch is used mostly in connection with high potentials and wherever a quick break is required. Mr. Trumbull retired from the company in 1916, since which time Mr. Vanderpoel has been the active head of the business, the growth of which has been remarkable under his management. The company has offices located in the following cities: New York, Boston, Philadelphia, Chicago, St. Louis, Detroit, New Orleans, San Francisco, Birmingham and Toronto, Canada. To show how far away the products of the company go, it might be mentioned that a steadily increasing trade carries them to the Far Eastern countries, and one of the largest switchboards ever built by the company was installed and is now in service in Constantinople. The remarkable growth of the Trumbull-Vanderpoel Electric Manufacturing Company has been in the short period of six years, and Mr. Vanderpoel, now only twenty-seven years old, ranks high among New England manufacturers. He was married August 29, 1914, to Jane Chester Cunningham, and they have one son, John A., named after Mr. Vanderpoel's father. Mr. Vanderpoel is a member of the B. P. O. Elks, Litchfield Country Club, The Sanctum, Bantam River Club and the Institute of Radio Engineers of New York. He resides in Litchfield, Conn.

VIELÉ, BLACKWELL & BUCK

The engineering corporation of Vielé, Blackwell & Buck was organized in New York, in 1906, to carry on a general engineering business, specializing in hydro-electric and steam power plants, electric transmission and distribution systems.

The partners in this corporation have, either as individuals or as a corporation, acted as consulting engineers, and in most cases as constructors also, of many power plants, among which are those of the Great Western Power Co., Appalachian Power Co., Great Northern Power Co., Schenectady Power Co., Arizona Power Co., Butte Electric & Power Co., California Electric Generating Co., Niagara Falls Power Co., Electrical Development Co., Northern Ontario Light & Power Co., Northern Canada Power Co., Mexican Light & Power Co., Guanajuato Light & Power Co., Cleveland-Cliffs Iron Co., and the St. Joseph Lead Co.

The partners in the corporation are F. O. Blackwell and H. W. Buck. Mr. M. A. Vielé, one of the original partners in the Company, died of pneumonia in New York City on April 10, 1915.

The Company's offices are at 49 Wall St., New York City.

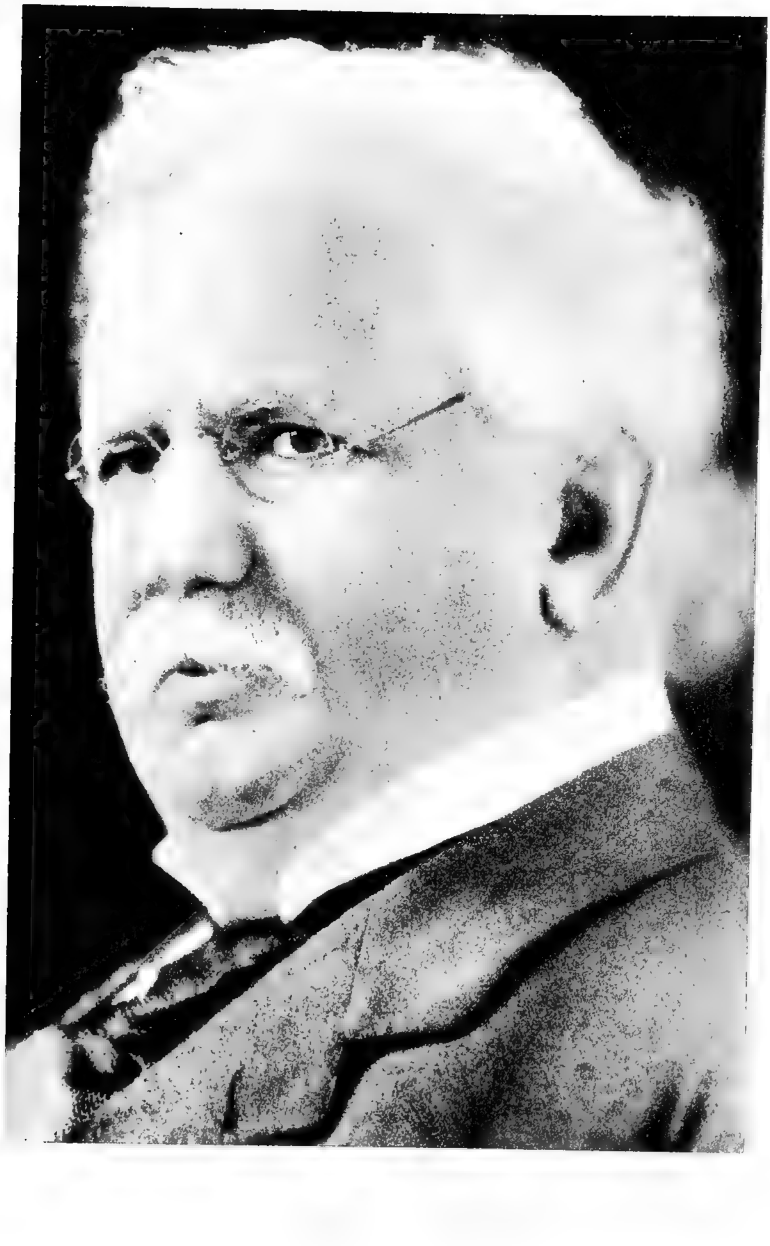
F. O. BLACKWELL

Mr. F. O. Blackwell, on graduating from the civil engineering school at Princeton in 1887, was employed by the Bentley-Knight Electric Railway Co. and had charge of the construction of the pioneer trolley roads at Allegheny City and Boston. When the Bentley-Knight Co. was taken over by the Thomson-Houston Co. he was made assistant engineer of the Railway Dept. On the combination of the Edison and Thomson-Houston Cos. he was appointed engineer of the Power and Mining Dept. of the General Electric Co. In 1904 he left the General Electric Co. to go with the late Dr. F. S. Pearson, with whom he remained as engineer in connection with the construction of power, railway and lighting plants, until the formation of the firm of Vielé, Blackwell & Buck.

H. W. BUCK

Mr. Buck graduated from Yale University in 1894 and then studied at Columbia University for one year, taking the degree of E.E. in 1895. After graduation he entered the shops of the General Electric Co. at Schenectady as a student and later became assistant to the Chief Engineer of the Lighting Department at Schenectady. In 1900 he was appointed Electrical Engineer of the Niagara Falls Power Co. in charge of the electrical engineering work of that Company and of its allied companies, the Canadian Niagara Power Co. and the Cataract Power & Conduit Co. of Buffalo. He remained at Niagara during the construction of the Niagara Company's No. 2 Power House on the American side and the plant on the Canadian side for the Canadian Co. In 1907 he moved to New York and joined the Corporation of Vielé, Blackwell & Buck, of which Company he is now Vice-President.

Mr. Buck was elected President of the American Institute of Electrical Engineers on May 16th, 1916, for the term of 1916-1917.



THEODORE N. VAIL

THEODORE NEWTON VAIL

Of the electrical corporations of the country the one of largest capital is the American Telephone and Telegraph Company, of which Theodore Newton Vail is President.

Mr. Vail was born in Carroll County, Ohio, July 16, 1845; was educated in the Morristown (New Jersey) Academy, and studied medicine two years under Dr. William Quimby, his uncle. But another relative, Alfred Vail, who was Samuel F. B. Morse's associate in completing and putting into operation the magnetic telegraph, inspired him with enthusiasm for things electrical. He learned telegraphy, was an operator in New York for a time and in 1869 became telegraph operator and station master of a station on the Union Pacific Railway. Later, through recommendation of General Grenville M. Dodge, he became a railway mail clerk, making such a record for efficient work that in 1873 he was advanced to assistant superintendent. He was promoted to assistant general superintendent in 1874; and from 1875 to 1878 he was general superintendent of Railway Mail Service at Washington. The practical ideas he had gathered were formulated into permanent improvements, and he made the service famed for efficiency.

Meanwhile, beginning with the exhibit of the Bell Telephone at the Centennial Exhibition in Philadelphia, he had watched with interest the development of the telephone. Thousands daily saw it tested at the Exposition and admired it as a wonderful scientific toy, but Mr. Vail saw how it might, by improvement in mechanism, be developed into a great public utility. Between the date of the Exhibition in 1876 and the time of his resignation of his office in the Railway Mail Service he had watched the experimental stages of the telephone business, had bought shares of telephone stock which he held without selling in days that were dark or on the occasional strong rises when speculators were collecting large profits. In 1878, when he resigned from the Railway Mail Service it was to accept the offered position of general manager of the American Bell Telephone Company, the reorganization of several Bell telephone companies. As general manager until 1884 and then president until 1887, Mr. Vail brought the company to a high plane of physical, administrative and financial efficiency. Then Mr. Vail, feeling that he was entitled to some rest, resigned from the presidency and spent three years in travel, first in Europe, with a long sojourn in Italy, and then across the Atlantic to Buenos Aires. Going inland, he was interested, near the City of Cordoba, to see a great reservoir of water, collected by damming the outlet of a wide cañyon with a narrow neck, for the purpose of irrigating an arid plain below, but with a surplus of thousands of units of water power tumbling over the parapet of the dam every hour. To his electrically-equipped mind the suggestion of this waterfall was such that he soon secured a lease of the use of this waste water, installed turbines and a station for dynamos and in a few months was furnishing light, traction and power to the City of Cordoba.

Going back to Buenos Aires, he found some of the leading thoroughfares occupied by the tracks of a dilapidated horse-car line. The line and franchise were for sale, and Mr. Vail secured the property for a small sum. Then he went back, by way of Brazil, to New York. He decided to retire to a farm, buying 700 acres near Lyndonville, Vermont, which has since, by additional purchases, increased to 7,000 acres. So pleased was he with his farm that for two years he forgot about his horse railroad in Argentina; but one day he began to plan, went to New York and got some friends interested with him, then sailed for Argentina and went to work buying or making traffic arrangements with ten other small roads. He placed orders for rails, dynamos, cars and equipment and in eighteen months had a modern trac-

tion system covering Buenos Aires. Mr. Vail had made the acquaintance of all the leading British capitalists of the city, and when the road was completed he sold it to an English syndicate at a very substantial profit to himself and his associate stockholders. Mr. Vail returned to his Vermont farm with the idea of a permanent retirement. But the death in 1905 of his wife and only son changed his objective, and when, in 1907, he was asked to undertake the executive duties of the entire Bell telephone systems as President of the American Telephone and Telegraph Company, he accepted, inaugurating new acquisitions and alignments which make it one of the world's greatest and most influential business organizations.

WAPPLER BROTHERS

Among the pioneers in the electro-medical field, the Wappler brothers deserve high honor. R. H. Wappler, cooperating with his brother Frederick H. Wappler, made the first commercial controller or rheostat by means of which it became possible to utilize the 110 volt or 220 volt current from the mains for the purpose of lighting small diagnostic lamps. In 1896 they worked on the idea of exercising the muscles by electricity. After careful experimentation they invented the slow moving sinusoidal current machine which made selective muscle exercise possible without mental exertion. The slow surging wave of this current gently contracts the muscles, forcing out the stagnant blood. Following this is a period of relaxation during which arterial blood flows into the muscular tissue. A series of such actions produces wonderful nutritive changes; atony, atrophy and paralysis are absolutely relieved, and in many cases cured where the vital fluid reaches the affected parts.

Another product of the Wappler Brothers' ingenuity is an electric surging wave generator, known as the Kymo-generator.

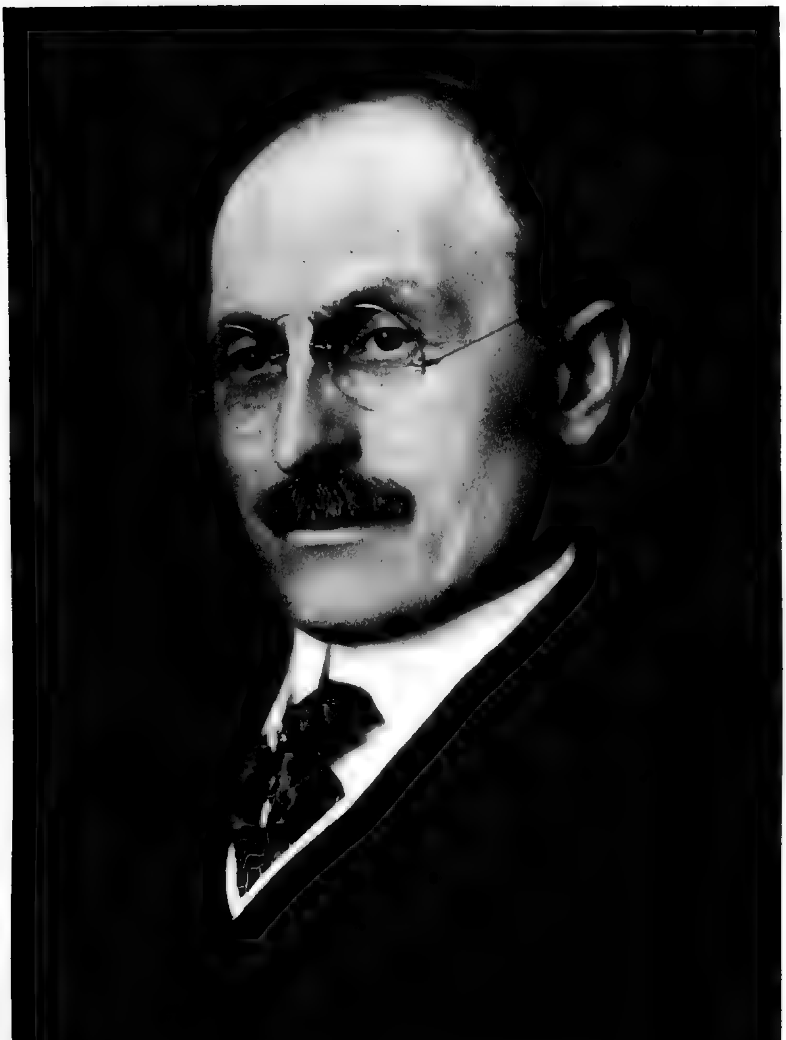
Medical science and practice has been measurably benefited by the many X-Ray machines which the Wappler Brothers have designed and constructed since 1899. Other uses of these remarkable machines range from the detection of flaws in metals to the conservation of oysters. In 1905 two of their machines were successfully used in Ceylon for the purpose of determining whether live oysters were pearl-bearing.

Later they invented the well-known King model interrupterless X-ray machine which was of great power and which is used extensively by the United States and other governments. This new machine was a radical departure from the existing state of the art. Whereas formerly, all X-ray machines had been constructed on the Rhumkorff Coil principle, the Wappler Brothers employed in this new type a closed magnetic core transformer by means of which 220 volts alternating current was stepped up to 120,000 volts. Efficient operation of an X-ray tube demands high-tension unidirectional current. The problem of furnishing such current was solved by a simple rectifying device consisting of a disc, having metallic contacts, which is rotated by a synchronous motor. For this invention a gold medal was awarded them by the American Institute of New York.

Much of the activities of the Wappler Brothers has been devoted to the development of electrically lighted diagnostic instruments of which the Cystoscope is the most important, inasmuch as it permits exact examination of and operation within the human bladder without the need for a major operation. With the aid of Dr. Otis Brown, Dr. Cabot, and Dr. Leo Buerger, the Wappler Brothers firmly established this industry in the United States, so that these American made instruments are now sent to all parts of the civilized world.

Concurrently with the development of the Cystoscope, a new therapeutic agent was being carefully developed. The proper use of high frequency currents in medical and surgical practice has had many and far-reaching effects. The Wappler Brothers designed and constructed many forms of high frequency machines, the

REINHOLD H. WAPPLER



FREDERICK H. WAPPLER

latest of which furnished the high frequency current in various forms including that by which tissue may be desiccated even though immersed in water. This action forms the basis of one of the greatest achievements in therapeutics, because vesicle tumors can now be destroyed electrically through the Cystoscope. The later high frequency machines of the Wappler Brothers are being used for heating through the chest in pneumonary tuberculosis. This method is recorded as having yielded four times higher percentage of cures than serum and other methods. These machines also supply a current to charge the surgeon's knife. When making an incision, the divided tissues are desiccated by the current, thus making the operation bloodless and aseptic, a great advantage in the removal of malignant growths.

Reinhold H. Wappler, president of the company, was born February 19, 1870, in the Duchy of Anhalt, Germany. He was educated at Wittenberg and Berlin, where he took special courses in Physics and Electrical Engineering. Coming to New York a few years after graduation he entered the employ of the General Electric Company as instrument maker and was later associated with the J. C. Vetter Company, and E. B. Meyrowitz as superintendent. He later joined his brother Frederick H. Wappler, who had some months previously begun the manufacture of electrical apparatus for the treatment of diseases.

Frederick H. Wappler, who is treasurer of the company, was also born in Germany on April 3, 1872. After being educated at Wittenberg he came to New York in June, 1891, and took up electrical work with the John C. Vetter Company, and was later employed by the Edison Company of San Francisco in installation work. In connection with C. H. Fayer, he organized the firm of Wappler & Fayer and began the manufacture of electrical instruments. The business was a success from its inception and nine months after its establishment, Reinhold H. Wappler joined the organization, the name of which was changed to the Wappler Electric Controller Company in 1898. The present company was incorporated in 1910, and in addition to the Wappler brothers includes C. H. Fayer, the original partner, as vice-president.

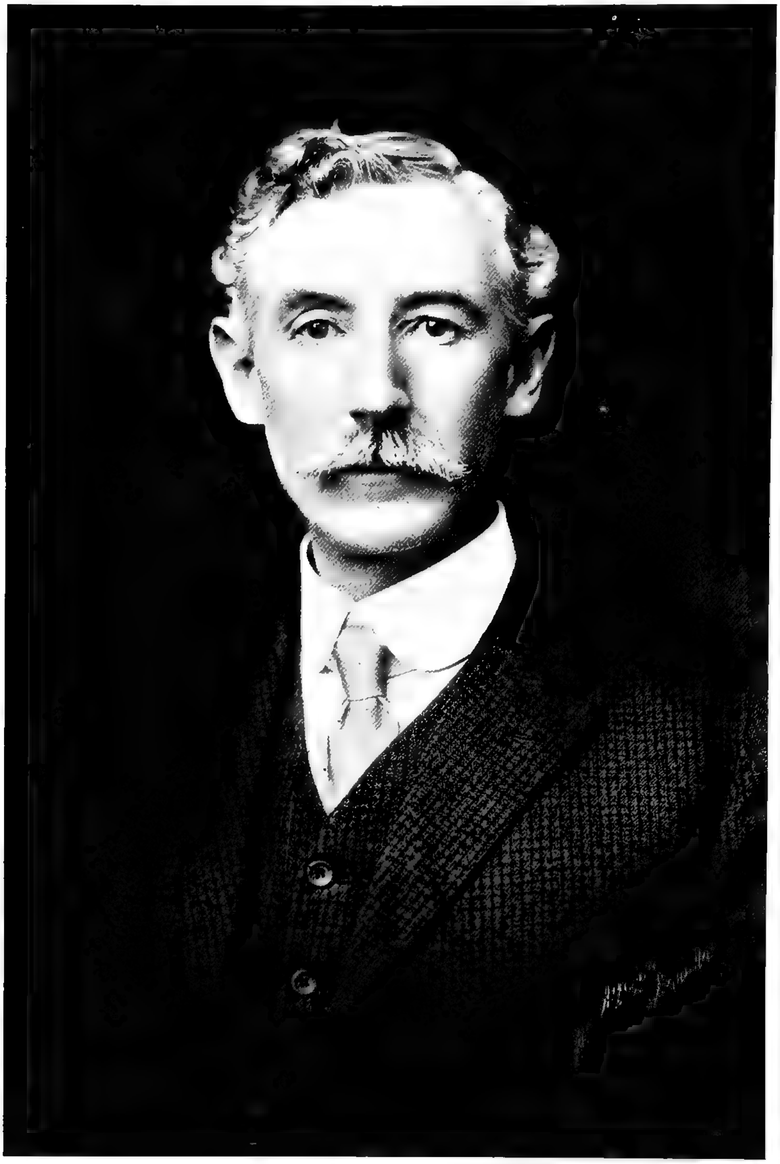
The knowledge and ability of the brothers, R. H. and F. H. Wappler, are deserving of the highest recognition and thanks of humanity. Their untiring efforts throughout a generation have resulted in applying the power of electricity very successfully in the cure of the sick and the relief of the suffering. The factory of the Wappler Electric Co. is located at 173-175 East 87th Street, with a branch at 1871 Ogden Avenue, Chicago, Illinois.

ARTHUR E. WATSON

The Department of Electrical Engineering of Brown University has from its organization in 1899 been under direction of Professor Arthur Eugene Watson, Ph.D.

He was born in Providence, R. I., March 4, 1866. On the paternal side his first American ancestor, a Scot, after fighting under Cromwell in Ireland, came to America; his maternal ancestry is Huguenot. After graduation from Waltham (Mass.) High School, Mr. Watson entered Brown University, from which he was graduated A.B., 1888, and Ph.D. in 1905. He is a member of Delta Phi fraternity and of the honor societies Phi Beta Kappa and Sigma XI.

He had read and experimented extensively along electrical lines as a boy, was ambitious to enter the electrical field, and through H. B. Chubbock, assistant electrician of the Narragansett Electric Light Company (whom he had, in his senior year, tutored in mathematics), he secured introductions to Professor Elihu Thomson and Messrs. Rice and Rohrer of the Thomson-Houston Electric Company at Lynn, and a position in that company's drafting-room at Lynn, Mass., beginning work there the day following his graduation in June, 1888. After working as



PROF. ARTHUR E. WATSON

draftsman for six months he became assistant foreman of the Drafting Department of that company and its successor, the General Electric Company, until 1895, when he resigned to organize and conduct a course of study in electrical engineering in Brown University, under the auspices of the Department of Physics.

During his second year at Lynn he became teacher of mathematics in the Evening High School, organized at the request of employees of the Thomson-Houston Company. He was lecturer on electrical subjects in the Brown University extension course, 1892-1893; entered the Physics Department as instructor in physics, 1895, later Assistant Professor of Physics, and since 1899 Assistant Professor of Electrical Engineering, but has always been the responsible head of that sub-department. He has an annual evening course of lectures in University Extension and contributes articles on electrical engineering in general or dynamo design and construc-

PHILIP D. WAGONER

tion to various popular or technical magazines. Prof. Watson is the author of several books on Dynamos, Storage Batteries, etc., and is a member of the American Institute of Electrical Engineers and associate member of the American Society of Radio Engineers, besides local and college societies.

PHILIP DAKIN WAGONER

A thorough technical and practical training fitted Philip D. Wagoner for any engineering position in the electrical field, but inherent executive ability and aggressive business qualifications eventually diverted his activities from the technical end of the industry to its commercial development. Mr. Wagoner was born July 24, 1876, in Somerville, N. J., and received his preparatory education in the public and high schools there. He afterwards attended the Stevens School and the Stevens Institute of Technology, graduating from the last named institution in 1896, with the M.E. degree. There was no electric course at the Institute but the instruction was such that he was ably equipped for his later work in the electrical field. After graduation, Mr. Wagoner became associated with the General Electric Company and entered the Students' Course for additional training in the line he had selected for his future work. His interest and aptitude for mechanical matters and a strong desire to enter the expanding field of electric development, were the factors that enabled him to quickly grasp the intricacies of the science and win the approval of the department heads. After a short time in the Students' Course, Mr. Wagoner was transferred to the Transformer Engineering Department at Lynn, Mass., where he remained until May, 1900. Thence he was sent to the company's plant at Schenectady, N. Y., where he was assigned to the office of the Engineer of the Supply Department, specializing in transformer work. In 1901, Mr. Wagoner, who had become proficient in all the details of this branch of the business, was delegated to organize and manage the Transformer Sales Department. The activities of this department continuously expanded under Mr. Wagoner's direction, and in 1907 it managed technical and executive sales activities in constant potential distribution and power transformers, constant current transformers for alternating current arc lighting systems, lighting arresters, mercury arc rectifiers, Tirrill and feeder regulators, rheostats and various other electrical appliances. In the early part of 1908, Mr. Wagoner, whom the company had come to recognize as a most valuable aid and asset, was transferred to the executive offices of the General Electric Company in New York City, where his duties were of a highly executive character. In 1910, he was elected to the presidency of the General Vehicle Company, an organization that has been a pioneer of the electric vehicle industry and a leading manufacturer of electric commercial vehicles in the world. In 1918 he became president of the Elliott-Fisher Company of Harrisburg, Pa., manufacturers of writing-adding machines. Mr. Wagoner is the son of Henry Gatzmer and Rachel Line (Dakin) Wagoner. His ancestors on the maternal side were among the oldest and most illustrious in England, several of the male members serving with William of Normandy and fighting valiantly at the Battle of Hastings. Mr. Wagoner was married in 1904, to Effie Nichols. He is deeply interested in all matters connected with the electrical industry and automobile trade and his affiliations are largely with technical organizations connected with the science. Among these are the National Electric Light Association, American Institute of Electrical Engineers, Society of Automotive Engineers, American Society of Mechanical Engineers and he is a representative member in the National Automobile Chamber of Commerce. He is also a member of the Engineers' Club, Railroad Club of New York, the Clove Valley Rod and Gun Club, and the Alpha Tau Omega fraternity.

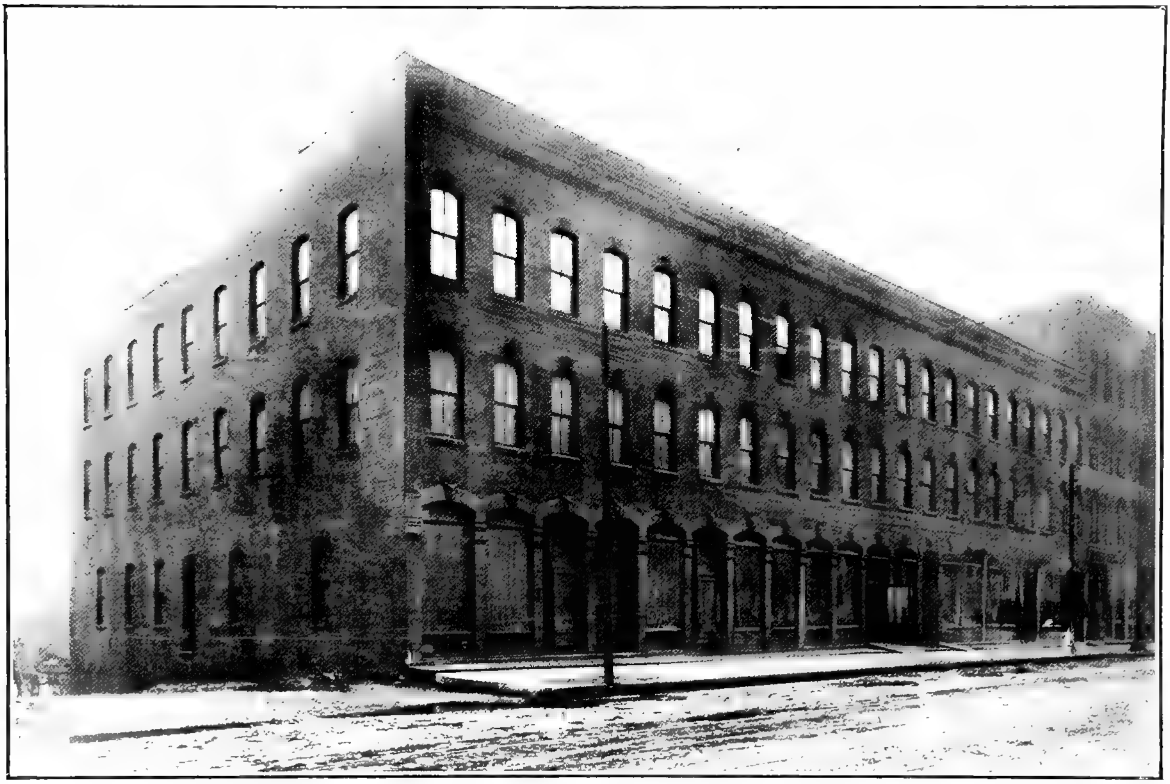
THE WESTERN ELECTRIC COMPANY

As a corollary to the story of the development of the telegraph and telephone there is a place for the history of the Western Electric Company, a history which is coincident with this development.

The Western Electric Company had its beginnings in 1869, when the partnership of Gray and Barton was formed by Elisha Gray, the inventor, and Enos M. Barton, at that time chief operator of the Western Union office at Rochester, New York. Their first shop was devoted to the manufacture of telegraph apparatus, bells, and buzzers. It was located at Cleveland, but removed to Chicago in 1870.

In 1872, when the Western Union Telegraph Company abandoned its big Illinois shop, a corporation, The Western Electric Manufacturing Company, was organized to succeed the firm of Gray and Barton, and take over the telegraph company's shop. This entailed a move to a new three-story building at Kinzie Street, near State, which was the company's home for about twelve years.

In 1879, three years after Alexander Graham Bell invented the telephone, the Western Electric Manufacturing Company took over the New York shop of the Western Union Telegraph Company. Up to this time the Western Electric had manufactured telephones for the Western Union, but this year saw the end of the latter's participation in the telephone business. The Bell Telephone Company thereupon entered into a contract with the Western Electric Company covering the manufacture of telephones and telephonic equipment under license exclusively for the Bell Telephone Company. This has been a continuing contract, and in connec-

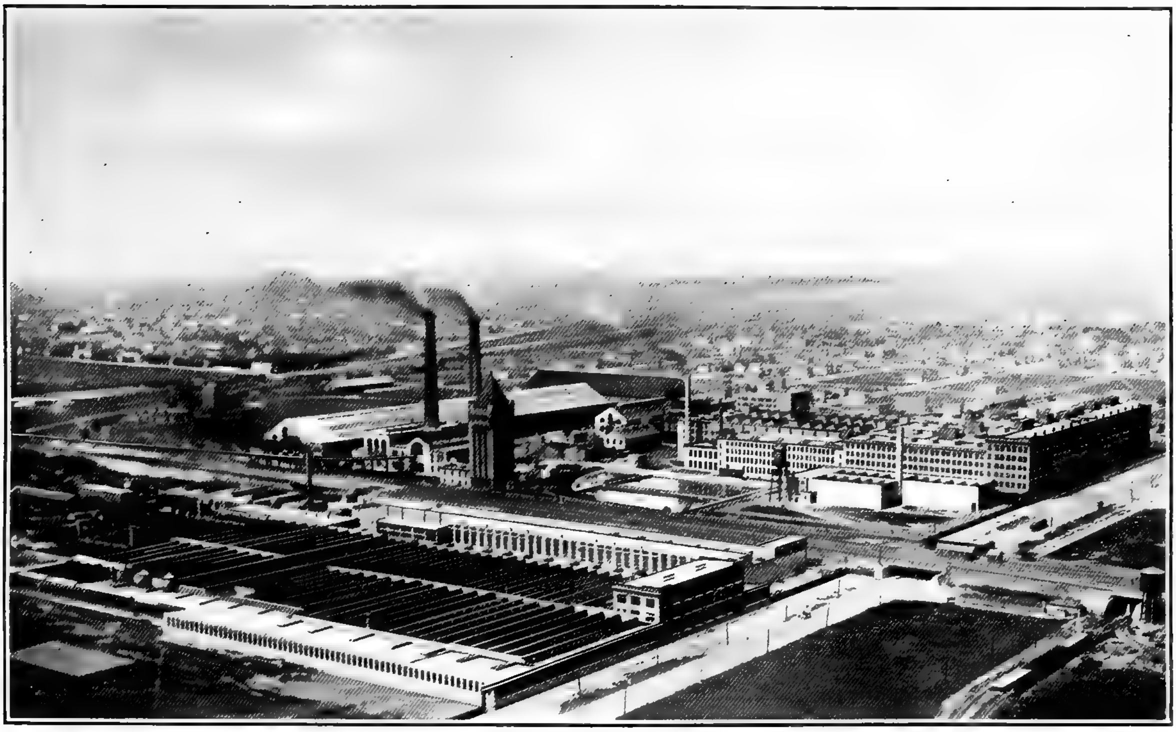


First Plant of the Western Electric Company at Kinzie Street, Chicago, Illinois, from 1872 to 1883

tion with its operation the Western Electric Company grew to be the world's largest manufacturer of telephone equipment and cable. As the business grew, a building was erected in Chicago in 1883 on Clinton Street near Van Buren. Further growth of the New York end of the business by 1889 made necessary a new building at Thames and Greenwich Streets, and this in turn was abandoned in 1897 for the larger edifice at West and Bethune Streets.

In 1908 H. B. Thayer was elected President of the company and still holds that office. Enos M. Barton, its president for the years previous, thereupon became chairman of the board of directors, retaining the chairmanship until his death in 1916.

Many notable contributions to the development of the telephone and telephonic equipment have originated in the research and development branches of the company's engineering department. Western



Aeroplane View of Present Plant of the Western Electric Company at Hawthorne, Illinois

Electric engineers have been largely instrumental in working out the problems of the multiple switchboard, the loading of transmission lines; and they played an important part in bringing about the completion of the transcontinental telephone line and the development of the transoceanic wireless telephone. Another comparatively recent achievement of great practical value is the multiplex printing telegraph by means of which eight messages can be sent simultaneously over one telegraph wire.

Even this plant equipment did not suffice long and in 1903 a new factory was started at Hawthorne, Illinois, six miles from the center of Chicago. At present all of the company's manufacturing activities are centered in this plant, which occupies approximately 210 acres of land, while the large thirteen-story structure at 463 West Street, New York, is now devoted principally to the activities of the company's engineering department. The company employed in 1918 upwards of 30,000 people.

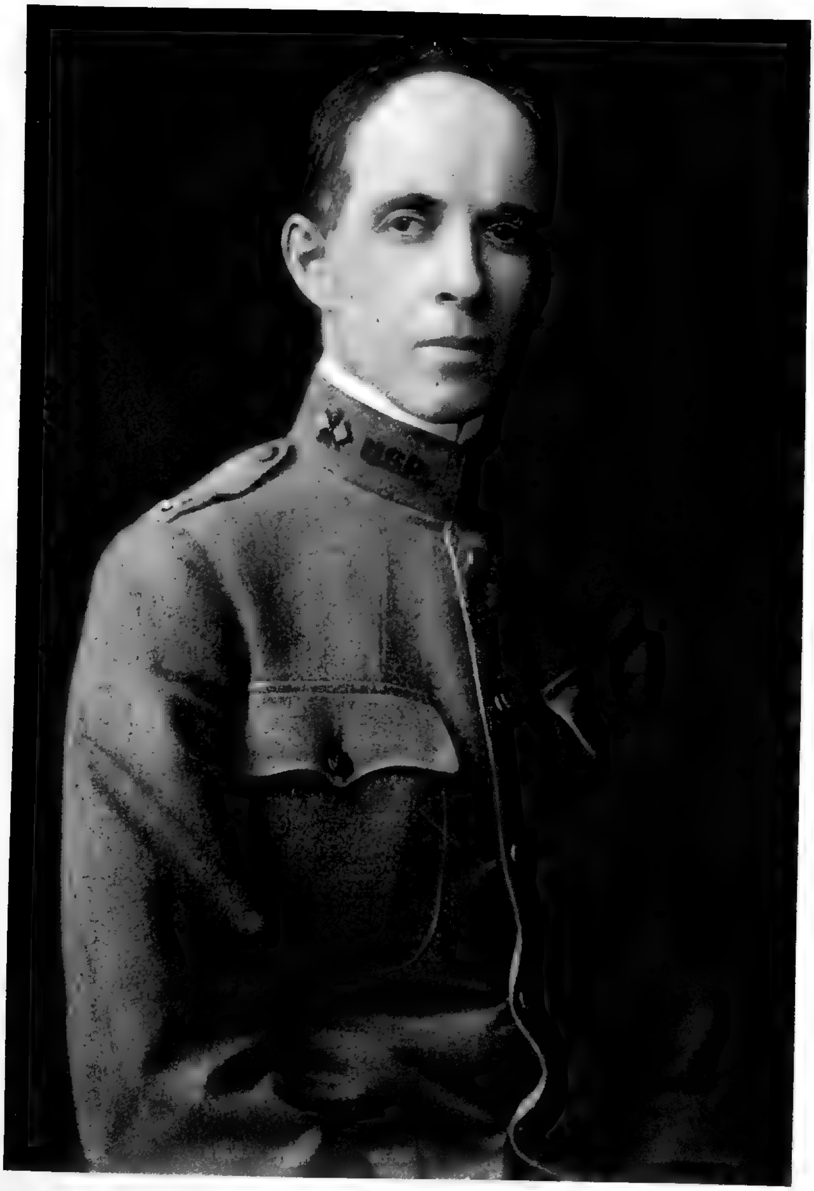
In addition to its engineering and manufacturing activities, the Western Electric Company is the world's largest jobber of electrical supplies. In this category are included appliances that make it possible to use electricity for turning the wheels of industry and performing the tasks of the home.

The company has during the past two decades built up a country-wide distributing organization consisting at present of thirty-nine houses, operating in the principal business centers of the United States.

Through its foreign affiliations, the company has taken on an international character. It has allied manufacturing organizations in Canada, in many of the European capitals and in Japan, while there is also a chain of foreign sales agencies which carries the Western Electric Company's products to all parts of the civilized world.

COL. FRANK B. JEWETT

Lieut.-Colonel Frank B. Jewett, Chief Engineer of the Western Electric Company, who has devoted his entire professional career to electrical research, was born in Pasadena, California, September 5, 1879. After a thorough preparatory education he took a course in electrical engineering at Throop Polytechnic Institute, Pasadena, California, graduating in 1898 with the A.B. degree. From 1898 until 1902, he was a graduate student at the University of Chicago, devoting his time to physics, mathematics and chemistry, and obtained the Ph.D. degree in 1902. From Chicago he went to Massachusetts Institute of Technology, and during 1902 and 1903 gave his entire attention to electrical engineering. During the years 1901 and 1902 he was Research Assistant to Professor A. A. Michelson, head of the Department of Physics at the University of Chicago, and during the time he was taking graduate work at the Massachusetts Institute of Technology he was Instructor in Physics and Electrical Engineering at that institution. Early in his career Dr. Jewett became vitally interested in the problem of speech transmission and the possibilities of the application of industrial research in the telephone field led him to enter that field for his life work. Late in 1904 he entered the Engineering Department of the American Telephone and Telegraph Company and shortly afterwards became head of its Research Department. In 1908 Dr. Jewett became Transmission and Protection Engineer of the American Telephone and Telegraph Company and remained in that position until the spring of 1912, when he was appointed Assistant Chief Engineer of the Western Electric Company, of which he became the Chief Engineer four years later. During the period he was with the American Telephone and Telegraph Company, Dr. Jewett was in responsible charge, under the direction of the Chief Engineer, John J. Carty, of the work leading up to the commercial introduction of phantom loading and loading of large-gauge open-wire circuits, the development of phantom or duplex cables, and the introduction of telephone amplifiers in a commercial way on loaded lines. In the latter part of his work as Transmission and Protection Engineer and during the first part of the time he was Assistant Chief Engineer of the Western Electric Company, he was in full charge of the work which resulted in the transcontinental telephone line and the general improvement in telephone transmission to the point where commercial service could be given over the entire United States. During 1914 and 1915, Dr. Jewett was in responsible charge and directed the work which resulted in successful wireless telephone transmission from the Arlington Station, Washington, D. C., to Panama, San Francisco, Honolulu and Paris. During his service with the American Telephone and Telegraph Company and the Western Electric Company, and particularly during the last eight or nine years, Dr. Jewett has been extremely active in introducing the use of scientific research methods as a means of expediting the solution of the problems which confront the telephone and telegraph indus-



FRANK B. JEWETT

try of today. In this work he has constantly acted as assistant to Col. John J. Carty, Chief Engineer of the American Telephone and Telegraph Company, and the results are shown by the very large departments of scientifically trained men in the engineering forces of the American Telephone and Telegraph Company and the Western Electric Company and also in the huge industrial research laboratories of the Bell Telephone system located at the Western Electric Company's plant. While born on the Pacific slope, Dr. Jewett is of New England ancestry, his direct ancestors founding the American branch of the family at Rowley, Massachusetts, in 1632, to which place they came from England. During the Colonial and Revolutionary days, and the early days of the Republic, the Jewetts were very prominent in all civic, religious and social matters in New England. Latterly, descendants of the original settlers scattered throughout the entire United States and have been active in civic and literary work. Dr. Jewett's great-uncle was for many years Librarian of the Boston Public Library, while another grand-uncle and his grandfather were the original publishers of Harriet Beecher Stowe's "Uncle Tom's Cabin." Dr. Jewett is a member of the Engineers' Club and the Machinery Club of New York City, also the University Club of Chicago. He was elected a member of the National Academy of Sciences in April, 1918. He was also recently elected Vice-President of the American Institute of Electrical Engineers. He is a member of the American Physical Society, the New York Electrical Society, the Society for the Promotion of Engineering Education, the Delta Upsilon Fraternity and the Telephone Society of New York, of which he was Vice-President for two years and President for two years. Dr. Jewett resides in Wyoming, Millburn Township, Essex County, New Jersey, and for the last ten years has taken great interest in civic matters there. He has been a member of the Board of Education for six years and its President for two years. The Western Electric Company, of which he is Chief Engineer, is the largest manufacturer of signaling apparatus in the world and makes practically all the telephone material for the entire Bell System. The Company's factory is located in Chicago and the immense plant there, together with the various branches in other cities, give employment to 30,000 people. The Engineering Department, located at 463 West Street, corner of Bethune Street, New York City, has 3,600 employees on its roll, and in the large building, covering the major portion of a city block, is located one of the most complete research laboratories in the country. The Government virtually took over this plant when this country entered the war, and in view of the extensive and particular knowledge which Dr. Jewett possessed on signaling matters and on the methods of attacking new problems, which would render him of inestimable value to the Government, commissioned him on May 1st, 1917, with the rank of Major, to direct the research and other activities of the Engineering Department. On December 15, 1917, he was promoted to the rank of Lieutenant-Colonel in the Regular Army, thus clothing him with additional power to conduct the work, which has been carried out with great satisfaction to the Washington officials. Subsequent to the declaration of war with Germany, Col. Jewett was instrumental in the raising of signal troops for the Army. He has also been actively engaged in securing groups of specialists to go to France in connection with the Signal Corps work. In addition to the national duties mentioned above which have been placed on him, Col. Jewett has been made a member of the Physics Committee, the Engineering Committee, and the Industrial Research Committee of the National Research Council and he is one of the four advisory members of the Navy Department's Special Board on Submarine Problems.

JAMES L. McQUARRIE

James L. McQuarrie, Assistant Chief Engineer of the Western Electric Company, was born in Bath, Maine, August 15, 1867, and educated in the public schools there. In 1882 he became associated with the Bell Telephone Company of Maine, which was later absorbed by the New England Telephone and Telegraph Company, remaining with that company until 1894. Starting as night operator at the telephone exchange in Bath, he successfully filled the positions of operator, inspector, manager and engineer in that service. During the early period of his career he was actively engaged in the introduction of telephone protective devices made necessary by the rapid introduction of electric power circuits. Mr. McQuarrie's engineering activities have been chiefly along lines of development of apparatus for telephone central offices and sub-stations and he collaborated with Mr. C. E.

Scribner in designing the original common battery multiple type of telephone switchboard now in universal use; it was, in fact, in connection with and largely because of this work that he became associated with the Western Electric Company. During his period of service with that company he was active among other things in the development of the engineering staff, which resulted in the organization of the Engineering Department of the Western Electric Company. In 1903 he was given the post of Assistant Chief Engineer. He is now in charge of the development of mechanical switching systems for the Western Electric Company, and in the course of his work has made ninety inventions relating principally to telephone devices.

EDWARD BEECH CRAFT

Major Edward Beech Craft was born in Cortland, Ohio, September 12, 1881, and his education in the public schools of Warren, Ohio, was followed by work in physics, chemistry and machine design under private instructors. From 1898 until 1902

he was associated with the Warren Electric & Specialty Company, in connection with the technical side of incandescent lamp manufacture, and from 1900 to 1902 he was superintendent of the Lamp Department of that company. In 1902, he became associated with the Western Electric Company at Chicago, Illinois, in the Engineering Department. Since 1904 he has been engaged in experimental and development work in connection with the production of telephone and telegraph apparatus and systems. In 1907 he was transferred to the New York office of the Company as Development Engineer in the Central Engineering Department, which was organized at that time, and in December, 1917, he was made Assistant Chief Engineer in charge of development and design. As Development Engineer he has been intimately associated with the development of so-called mechanical switching telephone exchange systems under the early direction of former Chief Engineer C. E. Scribner. He has given special study to the mechanical and electrical design of apparatus to adapt it to the modern factory methods of quantity production and has taken out more than sixty patents in connection with this work.

Major Craft is a member of the Engineers' Club. He is a member of the Committee on Telephony and Telegraphy of the American Institute of Electrical Engineers and the Executive Committee of the Telephone Society of New York. In the summer of 1916 he attended the Officers' Training Camp, Plattsburg, New York, and in March, 1917, was commissioned Captain, in the Signal Officers' Reserve Corps. He was called to active service May 21, 1917, and was promoted to Major on December 22, 1917. He now serves under Lieut.-Col. Jewett, who is Chief Engineer and in Government charge of the Western Electric Company's Engineering Department.

EDWIN H. COLPITTS

Edwin H. Colpitts, another of the group of Assistant Chief Engineers of the Western Electric Company, was born in Pointe de Bute, N. B., Canada, January 19, 1872. He graduated from Mount Allison University, Sackville, N. B., with honors in science and the degree of A.B., and the same degree was conferred upon him by Harvard University upon his graduation from that institution in 1896. He took a post-graduate course in physics, mathematics and engineering at Harvard and was awarded the M.A. degree in 1897. From 1897 to 1899 he was assistant to Professor Trowbridge in physics at Jefferson Physical Laboratory, Harvard University. He entered the Engineering Department of the American Bell Telephone Company in 1899, and from that time until 1907 was engaged on investigations relating to the loading of telephone lines, interference between power circuits and telephone circuits, and other matters relating to telephone and telegraph engineering. In 1907 he became head of the Physical Laboratory in the Engineering Department of the Western Electric Company. Four years later he was made Research Engineer of the company and retained that position until he was appointed Assistant Chief Engineer in 1917. During his early connection with the company he was in responsible charge, under the direction of Charles E. Scribner, then Chief Engineer, of the physical research and development work involved in the furnishing of phantom loading, applied both to large-gauge open-wire circuits and to large underground cables. He was also responsible for the physical research involved in the design of phantom or duplex cables. Later, under F. B. Jewett, who was then Assistant Chief Engineer of the company, he was in direct control of the work resulting in long-distance wire and radio telephony. During the past year, under Lieut.-

EDWIN H. COLPITTS

Col. Jewett, who is also Chief Engineer of the Western Electric Company, Mr. Colpitts has been largely interested in Signal Corps matters, and during 1917 spent some months in France, in connection with the establishment of a Signal Corps research laboratory for the American Expeditionary Forces. Mr. Colpitts is a Fellow of the American Institute of Electrical Engineers and the American Physical Society, and a member of the Telephone Society of New York, the Harvard Engineering Society of New York and the East Orange Rifle Club.

WILLIS RODNEY WHITNEY

Professor Willis R. Whitney, Director of the Research Laboratory of the General Electric Co., and one of the most distinguished of American scientists, was born in Jamestown, N. Y., August 22, 1868, the son of John J. and Agnes (Reynolds) Whitney. He was graduated from Massachusetts Institute of Technology, S. B., in 1890, became assistant and instructor in chemistry in that institution, 1890-1892,

WILLIS R. WHITNEY

then went to the University of Leipzig, 1892-1894, receiving the degree of Ph.D. in 1894, and returned to his former position in the Massachusetts Institute of Technology 1895-1900, and became assistant professor of chemistry in that Institute, 1900-1904. Since 1904 he has continued his connection with the Institute as non-resident professor of Theoretical Chemistry, and is term member of the Corporation, 1918-1922.

Through his college career and afterward he was always interested in the various departments of chemical and physical research and in his teaching positions was always an exponent of laboratory methods and an advocate of research as the strongest factor of scientific education. His own successful researches developed several new discoveries of scientific value, and his close daily connection with laboratory activities gave him a strongly held belief in the future and significance to humanity of research, and an equally strong conviction of the necessity for the development of research in American industry.

It was in 1904 that Prof. Whitney accepted his present position as Director of the Research Laboratory of the General Electric Co. at Schenectady, N. Y. The equipment of that laboratory as it has been developed under Mr. Whitney's direction is probably the most complete in the world for the purposes of research in the problems and applications of electricity and allied departments of chemical and metallurgical science. He has associated with him men of specially valuable experience and high attainments, and the laboratory is constantly evolving new and important discoveries which can be practically applied in electric and related industries. It was in this laboratory that tungsten, one of the most valuable adjuncts of modern electric lighting, and one of the most brittle and unstable of metals, was by patient research transformed by new processes and discoveries into a ductile and non-fragile metal—and other discoveries of equal or almost equal importance have been added year by year for the improvement of American industries.

Prof. Whitney has been a member of the United States Naval Consulting Board since 1915, and is a member of the National Research Council. He is a member of the American Chemical Society, the American Electro-Chemical Society, American Physical Society, a Fellow of the American Association for the Advancement of Science and of the American Academy of Arts and Sciences. He is a member of the National Academy of Sciences, the American Institute of Mining Engineers, the British Institute of Metals, and Associate of the American Institute of Electrical Engineers. He was president of the American Chemical Society in 1910, and received from it the Willard

HARRY M WARREN

Gibbs Medal in 1916. He was president of the American Electrochemical Society in 1911. He is a trustee of the Albany Medical College, a member of the Chemists and Technology clubs of New York, the Cosmos Club of Washington, and of the Mohawk Club of Schenectady, and he has a pleasant home in the suburbs of Schenectady.

He is ardently devoted to the interests of science, and outside of his professional work he finds recreation in researches in physical and colloid chemistry and other physiological processes.

HARRY MUNSON WARREN

There are few, if any, industries to which the ministrations of electricity in the form of light, power or motion are not applicable, or, where applied with proper installation, are not preferable to any other agency they may supplant. The horse for speed, the underground cable for traction, steam for many and multiplying forms of motive power, and many other agencies each accounted best in its day and sphere, have either abdicated or become secondary to electricity. This is the Electric Age, and the electrical engineer is making over the world and its forms of motion.

An industry which has been especially benefited by electrical equipment is mining, which in many of its operations has found greater safety and enhanced efficiency through the introduction of various kinds of electrical installation. Railroads, also, have been transformed in many ways by adopting electrical methods not only for the work of traction in place of or as an auxiliary to steam, but also in many road and track operations, in locomotive and car shops, terminals, docks, etc., the working of signals, and in other ways.

With a professional practice that has largely specialized in mining and railroad work, Harry Munson Warren, electrical engineer of the Delaware, Lackawanna & Western Railroad Company, has won his way to a place of distinction.

He was born in Worcester, Mass., November 22, 1875, was educated in Worcester Polytechnic Institute, being graduated B.S. in 1896, took post-graduate work in the same institution, specializing in electrical engineering in 1897, received the degree of M.S. in 1899 and E.E. in 1905. He was engaged in electrical contracting at Montclair, New Jersey, about two years, and spent one year in the Testing Department of the General Electric Company, at Schenectady, New York.

It was in April, 1900, when Mr. Warren was appointed electrical engineer in the Delaware, Lackawanna & Western Railroad Coal Mining Department, beginning a career of constructive and progressive usefulness in the application of electricity to coal-mining operations and for various new features of efficiency in the work of mining. He conceived and was responsible for the installation of an 800-H.P. automatic water hoisting equipment for Delaware, Lackawanna & Western Railroad Company, Coal Mining Department, at Scranton, Pa., for hoisting water out of the mine at a depth of five hundred feet. He has made a special study for the past ten years of burning small size anthracite fuel in the boiler plants of the Coal Mining Department, and has made more progress than any one along this line. This greatly conserves the nation's fuel supply as well as introducing a valuable economy. In 1905 Mr. Warren was appointed electrical engineer of the Delaware, Lackawanna & Western Railroad Company, including the Coal Mining Department, and in this larger and more comprehensive charge has been in touch with all the varied electrical problems of railroading as well as of coal mining.

His efforts have been directed more particularly to the problems of electrical haulage, pumping, hoisting, generating and power equipment of coal mines, including the generation of steam and electricity and its utilization; and also railroad electrical equipment of locomotive and car shops, terminal yards, etc.

As a specialist in the electrical equipment of coal mines he is well known in the profession. In 1911 he was the electrical member of a commission of six organized

by Joseph H. Holmes, chief of the Bureau of Mines of the United States Government, to study the coal-mining conditions abroad. The Commission visited and inspected coal mines in England, Wales, France, Belgium and Germany, Mr. Warren's attention being concentrated on the progress that had been made in those countries toward the electrical equipment of mines. His special knowledge and experience along these lines has led to his appointment on many important committees, and he is now member of the Mines Committee of the American Institute of Electrical Engineers, the Committee on the Use of Electricity in Mines of the American Institute of Mining Engineers, the Committee on Electrical Workings of the American Railway Association, the Electric Light Committee of the New York Railway Club, and the Committee on Standardization of Electrical Equipment in Mines of the American Mining Congress. In these organizations and in his regular professional work for the Lackawanna System Mr. Warren has been a leader in the work for a larger and better application of electricity to the operation of mines and railways in the direction of efficiency.

He is an associate member of the American Institute of Electrical Engineers, member of the American Institute of Mining Engineers, American Railway Guild, the American Mining Congress, and the New York Railroad Club. He has his office and residence at Scranton, Pa., where he is a member and past President of the Engineers' Society of Northeastern Pennsylvania, the Rotary Club of Scranton and the Young Men's Christian Association.

HOWARD SEARS WILSON

Howard Sears Wilson, of Waterbury, Conn., consulting engineer, was born in Baltimore, June 30, 1871, and is of distinguished New England lineage. He was educated in public schools and Maryland Institute, and attended special lectures at Johns Hopkins University. He was consecutively employed with the Baxter Electric Manufacturing Co., Baltimore, 1889, Wenstrom Electric Co., Baltimore, 1890;

HOWARD S. WILSON

Railway department, Thomson-Houston Co., Lynn, Mass., 1891; took the regular expert course in construction and engineering work, also special testing of railway and polyphase apparatus, General Electric Co., Schenectady, N. Y.; was one of the two men assigned to install the Baltic-Taftville 3 phase transmission plant, March, 1894, and in June, 1894, was appointed engineer in charge of the Columbia Mills plant, Columbia, S. C., the first electrically operated cotton mill in the South. He was with the Puebla (Mexico) Electric Co., 1897-1904, as engineer of their properties and 10,000 volt, 60 cycle, 10 mile transmission plants; equipped in 1904-1905 the first all-electric operated nitrate plant for the W. R. Grace Co., in the Province of Antofagasta, Chile, and other important installations; then, 1907-1916 with the New England Engineering Co., Waterbury, Conn., as Manager of the Power Equipment Department, building and installing many isolated industrial electric plants. He now conducts a similar business on his own account at Waterbury, Conn.

Mr. Wilson is a member of the Waterbury Club and a Fellow of the American Institute of Electrical Engineers.

GEORGE WEIDERMAN

GEORGE WEIDERMAN

The electrical industry includes among its representatives many men who have come into its later developments by the way of a practical experience in telegraphy. Among these is George Weiderman, now head of the George Weiderman Electric Company of New York and Brooklyn. He was born in New York City in 1864, was educated in the public schools of that city, being graduated in 1878. He later entered upon a telegraphic career in the service of the Western Union Telegraph Company, first as a clerk and afterwards as a telegraph operator and manager in New York and Brooklyn for ten years. It was a time of great development and initiative in the electrical industry, and during his entire period of telegraph service Mr. Weiderman was a devoted and eager student, not only of the art of telegraphy, in which he early became an expert of much skill, but also of the scientific principles and practice of electrical science and engineering. In the managerial positions which he filled under the Western Union Telegraph Company, Mr. Weiderman had demonstrated his business acumen and executive ability by steadily increasing the business of the offices placed in his charge. He had the natural ambition of a man of those qualifications to get into a business of his own, and having qualified himself by study and research, he established himself in 1891 in an electrical business as an individual venture. He soon built up a successful business in the installing of electric light and power systems in industrial plants, gaining a reputation for careful efficiency in work that brought him contracts for such installations not only from all sections of the Greater City, but from surrounding towns as well, the area of his activity constantly widening. The firm later became Weiderman & Conkling, but twelve years ago was incorporated as the George Weiderman Electric Company. Two years later he added to the business that of the manufacture of electrical appliances, for the prosecution of which the company has a capacious and well-equipped factory at 35-37 Rose Street, New York, turning out products to suit the most exacting modern requirements of electrical practice. The company's display rooms, warehouse and offices are at 191 Flatbush Avenue in Brooklyn, occupying the entire building through the block to Pacific Street, and carrying there large and constantly replenished stocks. Mr. Weiderman still makes a prominent feature of electrical work for industrial plants, installing power, light and telephones in plants of every kind and using the best and most improved fixtures, material, and insulations. He also executes contracts for the complete electrical equipment of buildings of every kind and for all purposes. Mr. Weiderman has developed his business along lines of constant progress, and has kept pace with the many new inventions and improvements which have so broadened the scope and expanded the activities of the workers in the electrical field, and as engineer, contractor and manufacturer has kept up with the times. He is identified with many of the leading and most important electrical organizations and societies, is a life member of the New York Electrical Society, the oldest of American electrical societies, and a member of the American Institute of Electrical Engineers, the National Electric Light Association, the Illuminating Engineering Society, the Jovian Order, Merchants Association of New York City, the Rotary Club of Brooklyn, Brooklyn Chamber of Commerce, Brooklyn Engineers Club, and the Electrical Development Society. He is in complete accord with the modern spirit of co-operative effort and union of purpose for the further advancement of the electrical industry both from a technical and commercial standpoint. He has met with a marked and gratifying success in his business enterprise because he has brought to it the benefit of his close personal supervision, and because he has kept up with the progressive development of the art in its rapid evolution. He has watched that development, so far as the applications of electricity to light and power are concerned, from their earliest commercial manifesta-

tions and has always had faith in the electrical business as one of the most stable, and as having a future of progress more strongly secured than any other. Mr. Weiderman is a resident of Brooklyn, and his social and club connections are chiefly in that borough. He is a member of the Crescent Club of Brooklyn, the Long Island Automobile Club and the Building Trades Club; and he is also a member of the Marine and Field Club, the Knickerbocker Club of New York, St. John Lodge, F. and A.M. and Kismet Temple. Outside of business his chief interests are church and charity work, and his favorite recreation is golf.

WALTER FARRINGTON WELLS

Walter Farrington Wells, Vice-President and General Manager of the Edison Electric Illuminating Company of Brooklyn, was born in Rahway, N. J., January 10, 1870, and joined the staff of the Brooklyn Edison Company in 1892, as a draftsman, after completing a special course in engineering, higher mathematics and chemistry at Rutgers College. He progressed from the position of draftsman to that of electrical superintendent, which post he occupied from 1894 to 1897, when he left the company to become assistant general manager of the Manhattan Electric Light Company. The next four years comprised the period during which the several central station companies in New York City were being merged to form the present New York Edison Company, and to Mr. Wells fell the responsibility of arranging many of the physical details of the transaction. The Manhattan company being included in the merger, Mr. Wells then became one of the district superintendents of the Operating Department of the New York Edison Company, and as such co-operated in the preparation of the plans, and superintended the installation of the electrical plant at the Waterside Station of the company, 38th Street and East River. Upon completion of this station in October, 1901, Mr. Wells was appointed superintendent in general charge of its operation.

In 1905, he was offered the newly created position of General Superintendent of the Brooklyn Edison Company, and in this capacity re-entered the service of that company, and on January 3, 1913, was elected Vice-President, General Manager and Director. He is likewise Vice-President, General Manager and Director of the Kings County Electric Light and Power Company; Vice-President and Director of the Amsterdam Electric Light, Heat and Power Company, and Director of the National City Bank of Brooklyn.

Mr. Wells has been actively connected with the technical work of the National Electric Light Association, and after twice holding the office of Treasurer, was in successive years elected 2nd Vice-President, Vice-President and President of this body. During the years 1915 and 1916 he held the presidency of the Association of Edison Illuminating Companies. In June, 1915, Rutgers College conferred upon him the honorary degree of Electrical Engineer. He is a fellow of American Institute of Electrical Engineers; member of American Society of Mechanical Engineers, Franklin Institute, Illuminating Engineering Society, Merchants Association of New York, New York Electrical Society, and Brooklyn Engineers' Club. His social clubs are Crescent, Brooklyn, Rotary, Engineers, Engineers Country and Delta Kappa Epsilon.

ARTHUR WILLIAMS

ARTHUR WILLIAMS

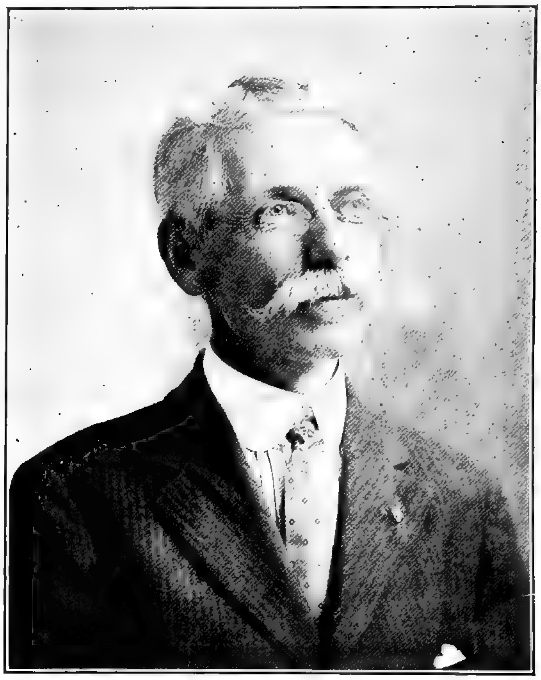
Arthur Williams, Federal Food Administrator of the City of New York, whose versatility is shown by his career in the electrical field and the executive ability displayed in the position to which the Government wisely appointed him, is a native of Norfolk, Va., where he was born August 14, 1868, the son of Rev. Christopher S. and Hannah Sanford (Rogers) Williams. He was educated in the public and private schools of Hartford, Conn., and New York City, and when sixteen years of age began his business career with an electrical contractor. He remained in this position from August, 1884, until February, 1885, when he became an employee of the Edison Electric Illuminating Company of New York, which was afterwards succeeded by the New York Edison Company. He was assigned to duty as assistant in the chemical meter department. From this period his advancement was rapid, due to his speedy grasp of conditions and the energy he displayed. He was made superintendent of interior construction in 1887, and was electrician of the company from that time until 1888, when he was advanced to the position of superintendent of the underground department, general inspector in 1890 and general agent in 1893. He was made the general commercial manager in 1915, a position he still retains. At the outbreak of the Spanish-American War, Mr. Williams was in charge of the Volunteer Forces which mined New York harbor. This work was done under the direction of the regular army, and he commanded a volunteer electrical force organized from members of local electrical companies. He served under Colonel William Ludlow, who was in charge of fortifications and torpedo defenses at Sandy Hook, N. J., and Major Henry M. Adams, who occupied a similar position at Forts Wadsworth and Hamilton. Mr. Williams has always taken an active part in accident prevention, a work that is carried on under the direction of the American Museum of Safety, of which he is president, and is deeply interested in various charity and philanthropic organizations. His connections with commercial enterprises are many and varied. He is president of the Electrical Show Company, New York Electric Garage Corporation, New York Electric Vehicle Association, Edison Savings and Loan Association, vice-president of the Yonkers Electric Light & Power Company, and director of the Metropolitan Life Insurance Company, and the Morris Plan of New York. He is a director of the New York Association for the Blind, Chrystie Street House, Upanin Club of Brooklyn, Municipal Art Society, National Employment Exchange and the National Safety Council. Other societies in which Mr. Williams holds membership include the American Institute of Electrical Engineers, of which he is a Fellow; New York Electrical Society (past president), Electric Vehicle Association of America (past president), National Electric Light Association (past president), Illuminating Engineers' Society, Association of Edison Illuminating Companies (past president), National Association of Corporation Schools (past president), Technical Publicity Association, American Association for the Advancement of Science, American Society of Political and Social Science, Municipal Art Society, Metropolitan Museum of Art, Society for the Protection of the Adirondacks, Electro-Chemical Society, International Engineering Congress, New York Zoological Society, Broadway Association, Chamber of Commerce of the State of New York, New England Society, International Law Association, of London, England. For the interest Mr. Williams has shown in French affairs, the Government of that country decorated him as an officer de la L'Instruction Publique, and for his work in connection with the American Museum of Safety the King of Spain made him a Knight of the Royal Order of Isabel the Catholic. Mr. Williams is a member of the Engineers' Club, Press Club, National Arts Club, Squash Club, Engineers' Country Club, Nassau Country Club, Lake Placid

Club, Lawyers' Club, Lotos Club, Aero Club of America, Union League Club, City Club of Yonkers, the Pilgrims, and Touring Club of France. Mr. Williams resides at 531 Fifth Avenue, and his office address is Irving Place and 15th street, New York City. As Federal Food Administrator for New York City, Mr. Williams rendered valuable assistance to Mr. Herbert Hoover, under whose direction he furthered the efforts of the Government for the conservation of food and the prevention of profiteering during the war.

ALBERT EDWARD WINCHESTER

A number of striking characteristics distinguish the part that Albert E. Winchester has taken in the advancement of electrical science. His has been the rare fortune to have participated in early pioneering endeavors, to have been associated with men and movements which made electrical history, and to have striven for ideals which he has seen realized in a measure, and which have earned him an honored place in the estimation of all who recognize unselfish service to the public weal as above the acquisition of wealth. To that vital issue, the relative merits of public and private ownership of public utilities, he has devoted a study of years' duration. He approached the question without prejudice on either side and was well qualified to have the voice that he gained among the representative public men who were convened by the National Civic Federation in New York in 1905. Among the results of that convention was the formation of a commission on public utility service, of which he was a member, when with other electric light, power and civic service experts he was sent to England, Scotland and Ireland with a corps of assistants at their command. An exhaustive investigation was made of the gas, electric, and street railway systems of those lands, while similar work was being performed in the United States. The resulting voluminous report stands as the most authoritative word on public utilities yet produced. Mr. Winchester's private opinion has been that the success of public utilities, whether publicly or privately owned, depends solely upon honest, businesslike methods. He has proved his convictions practically by his success in building up the publicly owned South Norwalk (Conn.) Electric Works—which he designed and supervised the construction of in 1892, and is its General Superintendent—while in the meantime he was President for several years of the privately owned water and electric service company in the adjoining town of Westport.

Back in 1886 Mr. Winchester was the



ALBERT EDWARD WINCHESTER

youngest member of the parent Edison Company's engineering staff. In the ranks of the Edison organizations he progressed from draughtsman to constructing engineer until the formation of the General Electric Company, with which he remained until 1893, when he became superintendent of construction and a director of the Electrical & Mechanical Engineering Company of New York, and for about two years until late in 1897 he was connected with the

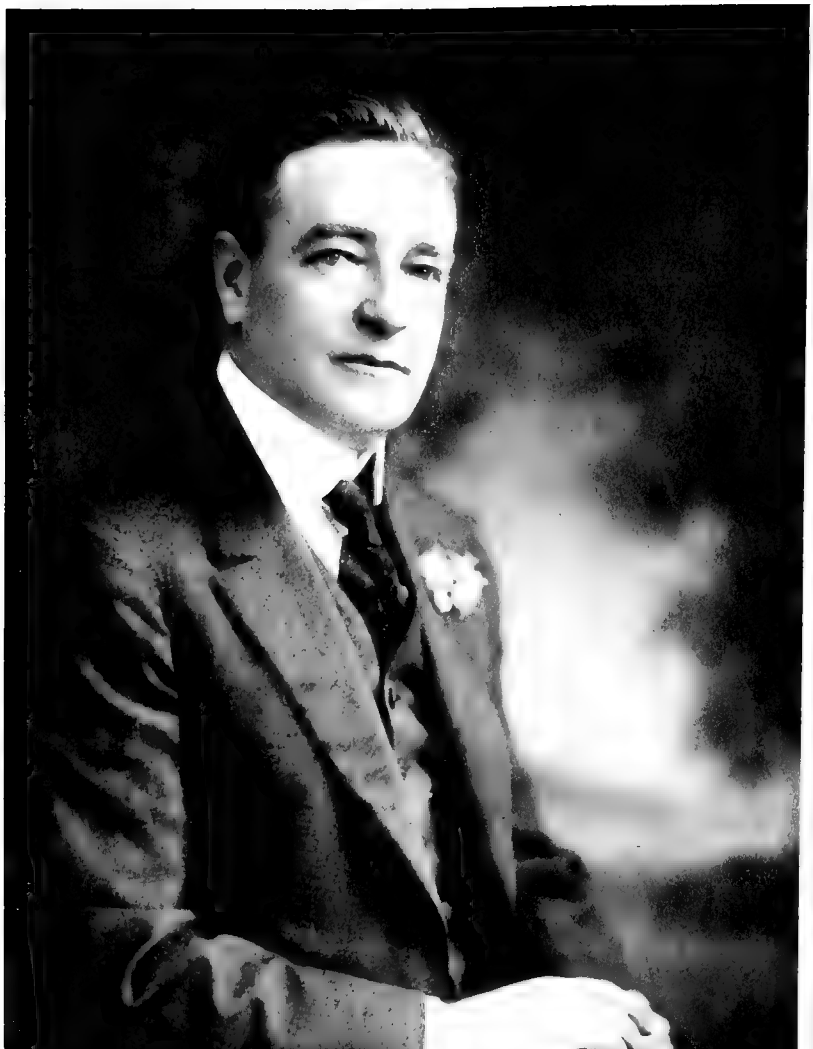
HARRISON WILLIAMS

engineering work of the New York Edison Co. Throughout this time he had charge of many important undertakings, designing and participating in the construction of over one hundred electric lighting and street railway generating stations, including Edison stations at New York, Boston, Chicago, Philadelphia and other large centers. Mr. Winchester values highly his experience in working under the personal direction of Thomas A. Edison. He is himself an inventor who, though not having taken out patents, has originated many appliances of practical consequence which were contributed to those whom he served, such as one of the first quick-break switches for heavy electric currents, a sectional iron bracket pole for supporting trolley wires, and an automatic trolley pole and contact for electric train service. In 1918, in collaboration with the General Electric Co., he helped to evolve a new economic electric street lighting unit now in use in his home city, South Norwalk, Conn. Mr. Winchester was born April 19, 1867, at Marietta, Ohio. He is a Founder Member of the Edison Pioneers and a Fellow of the American Institute of Electrical Engineers, an honorary member of the National Association of Stationary Engineers, a Mason of high standing, an Elk, a Redman, and a member of numerous other societies.

HARRISON WILLIAMS

To do justice to the story of how the name of Harrison Williams has become known throughout the public utility field would require more latitude than space limitations here permit, even if the subject were inclined to help the historian. But one of the conspicuous traits of Mr. Williams' character is that he insists upon his accomplishments standing in place of words and leaves the world to draw its own conclusions. Public and professional opinion record as matters of fact that beneficent, constructive effect of his exceptional organizing and administrative ability in all of the many industries he has touched. It is as a financier, a capitalist whose wise supervision over the financial structure of great enterprises has opened avenues of success to others, that he comes into relation with the electrical industry. The scientist, the inventor, the engineer, the electrician, the whole army of workers who make the wonderful forces of electricity serve the common purposes of daily life, all must depend upon commercially and financially trained men to direct their energies into profitable channels. Harrison Williams is not one of the old-timers or veterans about whom a web of reminiscence may be woven; in contrast, he belongs to the decade just passed, to the present, and still more to the future. The astonishing element in reviewing his career is that, arriving in New York fifteen years ago, unheralded and unheeded, he should have risen so rapidly in the trust and confidence of the business world as to make his name today a password into the innermost circles of America's financial center. If there is such a thing as romance in business, this is surely a striking example of it. Mr. Williams comes from Ohio. He got his public school education at Elyria; the family had removed from Avon, where he was born March 16, 1873, and his father was filling the position of County Treasurer of Lorain County. In 1892, at the age of 19, when most boys have not begun to think of responsibility, he became a manufacturer, and a successful one, by taking charge of a small concern employing a few men, known as the Fay Manufacturing Company, and making of it a large paying and producing factory. The list of commodities that he has since assisted in putting upon the market is a long one, but the reiterated item is electric power, heat, light and traction companies in all parts of the country. The beginning of his dealings in public utilities may be traceable to the influence of his friends, Charles A. Coffin and Anson W. Burchard, of the General Electric Company. However that may be, his interest in electrical power propagation has steadily increased within recent years, and it is prob-

able that the future may find him in close personal touch with the more strictly engineering as well as financial factors of the industry. He is now a member of the executive committees and directorates of the American Gas & Electric Co., the Electric Investment Corporation, the General Vehicle Company, the Mahoning & Shenango Railway & Light Co., the Peerless Truck & Motor Corporation, and the Motor Car Co., the Peerless Worthington Pump & Machinery Corporation; president of the Cleveland Electric Illuminating Co.; president, member of the executive committee and director of the Republic Railway & Light Co.; chairman of the board of directors of the Central States Electric Corporation, and the Federal Utilities, Inc.; director of the Denver & Rio Grande Railroad, etc., etc. The enumeration might be continued to the extent of several score companies in the policies of which he has been concerned. While it is obviously impossible for any man to divide his time between such a multiplication of demands, it is possible for a man of Mr. Williams' calibre to indirectly accomplish the same results through the medium of other men. Indeed, if his success could be attributed to any one principle, it would be to that of the correct judgment of human nature. He knows how to appraise the value and needs of a business and then how to find the right men to attend to them. This same faculty has made his aid invaluable to the great philanthropic movement embodied in the Charity Organization Society of New York. His co-operation in the society's efforts to put its affairs on a sound financial basis was the beginning of his connection with it, and he has since acted as trustee and chairman of the Finance Committee. He was one of the founders of the Neurological Institute of New York and is the present treasurer and a trustee. During the war Mr. Williams had the distinctive honor of being a dollar-a-year man. He acted as assistant to Bernard M. Baruch in the executive offices of the War Industries Board. Away from business Mr. Williams is an ardent devotee of sports, especially riding, motoring and golfing, belonging to the Riding, Automobile of America, and National Golf Links of America clubs; the Metropolitan Club and Riding and Hunt Club of Washington, D. C.; also the Metropolitan, the City Midday, Recess, Blind Brook, Morris County, Piping Rock, Sea View, and Sleepy Hollow Country clubs. It is a pleasure to present in connection with this biography a very good likeness of Mr. Williams, a rare privilege because of his habitual avoidance of the limelight. Mr. Williams' New York offices are at 60 Broadway.



C. GRIFFITH YOUNG

CHARLES GRIFFITH YOUNG

C. Griffith Young was born in Bath, Steuben County, New York, November 1, 1866. He was graduated from Haverling Academy in 1885 and began his business career in 1886 with the Schuyler Electric & Manufacturing Co., of Hartford, Conn.

Mr. Young had always been interested in mechanics and chemistry, and it was a question of opportunity with him whether he should take up the practice of electrical engineering or manufacturing chemistry. The opportunity presenting itself, Mr. Young accepted the position with the Schuyler Company, having before 1886 invented some new electrical devices, and believing that electrical enterprise was certain to have a great development. Outside of the several ideas which were covered in patents granted to Mr. Young, his chief interest and endeavor was in the commercial application of engineering problems, rather than in the manufacture of apparatus, and, therefore, in December, 1887, he accepted a position as General Superintendent of the Mount Morris Electric Lighting Company in the City of New York, which granted him a wide opportunity for executing some of the pioneer work in underground electric cable distribution on high tension, alternating current. Within three years this company, which had only a charter when Mr. Young identified himself with it, had two steam power stations and a distributing system extending from the Battery to 181st Street on the West Side. Some of the earlier principles in connection with governmental control of electrical utilities were developed in this period, as this work and its establishment had to be done under the approval of the Electrical Commission of the State of New York (New York Board of Electrical Control), believed to be the first governmental authority on public utilities. During this period the feasibility of underground cables and conduit systems for large cities was practically demonstrated. So thoroughly was some of this work done that high tension cables installed in 1889 are still giving satisfactory service.

After having this broad experience in the electric lighting and power field, Mr. Young desired to enter the electric railway field and he joined forces in 1902 with J. G. White, taking complete charge of the construction work in the City of Baltimore, involving the electrification of over 250 miles of horse railways. So extensive and successful was the work that the Company's headquarters were moved from New York City to Baltimore.

Mr. Young has been very active in the construction of electric railways in all parts of the country, having had the responsibility of the construction and equipment of over 2,600 miles of electric railways. He constructed one electric railway complete and put cars in operation in 22 hours' time in 1907. This is still the record for quick work.

In 1895 Mr. Young's first business trips on foreign experience began, and his knowledge of electric railways and electric lighting and power in their every phase has been the occasion of his being called to all parts of the world, including two entire circuits of the globe, three trips to China and the Far East, South America, New Zealand, Australia, Philippine Islands, Hawaiian Islands, etc.

The nature and extent of Mr. Young's work and experience has prevented his devoting to the purely technical engineering development the time he had always hoped to give, but has brought him into intimate contact with the practical engineering experience of the various engineering branches, including mining engineering, hydraulic engineering, civil engineering, as well as mechanical and electrical engineering. His first work, however, was that of electrical engineering; he joined the American Institute of Electrical Engineers in 1889 and was elected a Fellow in 1913.

Mr. Young has been particularly interested in and is an authority on the commercial application and solution of engineering problems and for developing the earning ability of public utilities and industrials.

The many countries Mr. Young has visited and his broad experience and

acquaintance has given him a storehouse of facts and information which is invaluable in the practice of his profession as a general consulting engineer, since 1909. He is identified with the following clubs and societies: Fellow, American Institute of Electrical Engineers; Associate, American Society of Civil Engineers; Member, American Electric Railway Association, National Electric Light Association, New York Electrical Society, New York Railroad Club, Engineers Club, New York City; India House, New York City; Pan-American Society of the United States, The Academy of Political Science in the City of New York, Circumnavigators Club and the National Foreign Trade Council.

OWEN D. YOUNG

Owen D. Young, vice-president of the General Electric Company, is a lawyer by profession and was a member of the legal firm of Tyler & Young, Boston, Mass., before forming his present connection. He was born in Van Hornesville, N. Y.,

A. A. ZIEGLER

October 27, 1874, and educated at St. Lawrence University, Boston University Law School. He received the A.B. degree upon graduation from the St. Lawrence institution in 1894, and Boston University Law School conferred the LL.B. degree upon him when he finished its course in 1896. Mr. Young was lecturer at the Law School of Boston University from 1897 until 1904. In addition to his interest in the General Electric Company, he is a director and member of the Executive Committee of the Electric Bond & Share Company, Director Bankers' Trust Company and a trustee of St. Lawrence University. He is a member of the American Bar Association, the Massachusetts Bar Association and the Beta Theta Pi and Phi Delta Phi fraternities. His clubs are the Bankers', India House, Lotos and Railroad Clubs of New York, Greenwich Country Club and the Union Club of Boston. Mr. Young was married June 30, 1898, to Josephine Sheldon Edmonds, of Southbridge, Mass.

ALFRED ARTHUR ZIEGLER

Contact and association with some of the noted scientists who were prominent in the early adaptation of electrical energy to the many uses which has made it one of the greatest known forces, was of incalculable value to Alfred A. Ziegler, for the research of these eminent men led his thoughts from ordinary mechanical work to other branches of the industry and in a few years transformed him from a journeyman electrician to a leading position in the manufacture of electrical apparatus. Mr. Ziegler was born October 4, 1864, in the city of Arbon, Lake Constance, Switzerland, the son of F. Jacob and Emilie (Habisreutinger) Ziegler. His grandfather was an agriculturist and a large manufacturer of cotton and worsted goods, which were exported to Italy, Turkey and America. The factories and farms had 1,000 employees and Mr. Ziegler's father continued the business for some years after the elder Ziegler's death. Mr. Ziegler's father was also in public life, being a member of the Swiss Legislature for fifteen years and holding various other offices. In 1847, he was a lieutenant in the Swiss military service, during the short war in behalf of an undivided confederation against the secessionist cantons. Mr. Ziegler was brought to America when a small boy, and the family locating in Boston, entered him as a pupil at one of the city's public schools. His preliminary education was finished in the schools of Malden, Mass., in 1879, after which he attended lectures at the evening school of the Massachusetts Institute of Technology for several years. His first employment was as an apprentice with Charles Williams, Jr., manufacturer of telephone and telegraph signals and scientific apparatus. Mr. Williams was located at 109 Court Street, Boston, in the building where Prof. Bell invented the telephone, and it was there Mr. Ziegler was brought in close touch with such famous men as Prof. Bell, Prof. Blake, of transmitter fame; Emil Berliner, transmitter and graphophone inventor; Moses G. Farmer, of the electric locomotive; Mr. Anders, of the printing telegraph; Thomas D. Lockwood, famous for his telephone connection work; Thomas A. Watson, also a telephone expert, and E. T. Holmes, who was in the same field. Mr. Holmes conducted the first telephone exchange in Boston and was the originator of the electric protective burglar alarm system which bears his name.

Mr. Ziegler was four years as an apprentice with Mr. Williams and one year with the Western Electric Co., which succeeded to the business. He then spent some time in the South Boston Iron Works to familiarize himself with the handling of

large machinery. During this period he studied engineering at nights and in his spare time during the day. In 1886, he entered the electric lighting business, making the first experiments with the Schaefer Electric Manufacturing Co. on incandescent lamps and other apparatus. He then returned to the Williams Works, then operated by the Western Electric Co. Upon the removal of that company to New York City, Albert L. Russell assumed the local business and he was in turn succeeded by the Holtzer-Cabot Electric Co. After a term spent in the service of the Western Electric Co., the American Bell Telephone Co., and the Holmes Electric Protection Co., he formed a partnership with his brother, J. Oscar Ziegler, in May, 1889, under the firm name of Ziegler Brothers, and began the manufacture of fine electrical and mechanical instruments. The venture was successful and the business of A. P. Gage & Co., dealers chiefly in physical and chemical apparatus, was absorbed. The Ziegler Electric Company was then incorporated, with A. A. Ziegler as president, and the new organization started out fully equipped to furnish the highest-grade apparatus for colleges, high, grammar and graduating schools. It also handled electric lighting paraphernalia, telephone and telegraph instruments and dynamos for power and hand use. In addition all the apparatus called for in Prof. A. P. Gage's series of textbooks on physics were among the specialties manufactured, as well as the so-called Harvard apparatus. In 1897 Mr. Ziegler severed his connection with the firm and organized the Ziegler Apparatus Company. He finally established the United Electric Apparatus Company and since 1910 has been located at his present address, Columbus Avenue and Centre Street, Boston, Mass. He is treasurer and general manager of the company, which is engaged in the manufacture of telegraph and telephone instruments and their allied connections, burglar alarms and signal apparatus for many of the railroads of the country, public service corporations and the United States Government. Mr. Ziegler occupies an envied position in the electrical field by reason of his having been in such close touch with the birth of the telephone and on such intimate terms with Prof. Bell and other noted scientists. It was at this period, 1872, that his brother made the original model for a multiple telegraph, and later worked on the telephone for Prof. Bell, the Blake Transmitter and the magneto bell. Mr. Ziegler relates some experiences he had when employed by the American Bell Telephone Company. He was engaged in some unique investigation and detective work in the early days of the telephone to ferret out the infringers on its patents and it required great vigilance to secure results. On one occasion Mr. Ziegler was sent by the American Bell Telephone Co. to locate a complete set of apparatus consisting of telephone transmitter, bells and switching devices that were being used by private parties, furnished by the telephone company for exchange systems which they were operating through several cities in Maine. Starting from Boston he went to Portland, at which place he could not locate any. He went to Lewiston next, locating several; then to Livermore Falls, where he was unable to find any. From there he went to Farmington, where he found several in stores and offices. Finally he went to Leeds and Phillips, Maine. At Leeds he got possession of evidence and saw instruments in operation, that enabled him, after two weeks' search, to get full data. Coming back, he was able to make a complete outfit which resembled the ones used by this company so closely that they could not be distinguished and were used by the American Bell Co. in their suit against the infringers. Another incident was at the death of President Garfield, when Mr. Ziegler helped Professor Alexander Graham Bell in making parts for an apparatus called the induction balance, with which Prof. Bell figured he would be able to locate the fatal bullet. In the early 80's he also aided Prof. Bell in setting up and making connections for the apparatus at the Massachusetts Institute of Technology, where the Professor gave

a lecture and demonstrated the first experiment on wireless telephony by the rays of the sun. This was called the photophone and messages could be heard for distances of about 300 feet from the receiving instrument. Mr. Ziegler is a charter member of the Boston Electric Club and a member of the Transportation Club of New York City, the Bay State Automobile Association and the Central Club of Boston. His New York City office is located at 30 Church Street.

CHAPTER X

ELECTRICITY IN THE HOME

NOT only in the aggregate volume, but also in its diversity of applications, the progress of electricity has far outrun the rosiest hopes of its inventors and exploiters of the Seventies and Eighties, when its first excursions into the realm of production of light, heat and power began, though they all appeared extravagantly optimistic to their lay contemporaries.

Even men of science, duly appreciative of the wonderful scientific value of the experimentation and application of electric light and power, were for years imbued with pessimistic ideas about the commercial success of such electric service. Few, however, as late as 1879, were willing to go as far as W. M. Williams, a fellow of the Royal Academy of Science of Great Britain, who in a paper entitled "Contribution to the History of Electric Lighting," published that year, after narrating some early lighting experiments, wrote:

"During the intervening thirty years I have abstained from further meddling with the electric light, because all that I had seen then, and have heard of since, has convinced me that although as a scientific achievement the electric light is a splendid success, its practical application to all purposes where cost is a matter of serious consideration, is a complete and hopeless failure and must of necessity continue to be so."

But this was only a few years before the permanent value of the electric light and its commercial success had been placed beyond controversy. Like the telegraph and the telephone, it took years to educate the people in its use, but when the prejudices of conservatism had been overcome it became a necessity to those desiring the best and most dependable form of illumination.

Electric power for the industries came next. It was much longer coming to its own. The dynamo and motor took a considerable time in evolution. Even after it had reached a satisfactory degree of efficiency and reliability and the users of power were convinced of the greater desirability of electrical equipment, many of them kept the steam plant because it represented a considerable investment which they felt that they could not afford to discard. But as new equipment was needed it would be electrical, and finally the entire plant would be transformed from steam to electricity.

The fact that heat can be produced by electric energy has been known for at least one hundred and fifty years, but the practical applications of that principle to the uses of the home was long in coming. The first public exhibit along that line was at the International Exposition at Vienna in 1883, where water was boiled by electric heat, first by means of a spiral of platinum wire made red hot by electric current and then immersed in the water, and at another time by winding the platinum wire around the vessel which contained the water.

Since the use of electrical energy for light and power has been developed there has been no question of the possibility of electric cooking and heating. The prob-

lem of their use has been economic rather than technical or mechanical. From the side of central station management, it has been whether electric energy for these purposes can be supplied at a profit to the station, at a price low enough to put electricity in anything like even competition with other kinds of fuel. Scientific and mechanical demonstrations clearly established the fact that electric heat could be obtained, and that for cooking and many other operations it was ideal, but the question of profit in its generation and distribution on the one hand, and from the consumers' side that of the cost of installation and maintenance, served to retard the development of electrical applications, other than lighting, in the home.

From about 1890 electrically heated cooking utensils, such as hot plates, tea kettles and chafing dishes began to be shown at various exhibitions in this country and abroad. The commercial use of electric heating in England dates from an exhibition of such appliances made at the Crystal Palace at Sydenham, near London, in 1890, by the Carpenter Company, American manufacturers. After that many patents were taken out in England by several inventors of such appliances. One of these inventors, H. J. Dowsing, in conjunction with the Crompton Company, manufacturers of electric appliances at Chelmsford, England, organized a banquet given to the Lord Mayor of London on Friday, June 15, 1894, at the Cannon Street Hotel, London. At this banquet the food was all electrically cooked, and the visitors were invited to see the cooking operations in progress. The interest aroused in London and through England by that banquet had a very stimulating effect on the sale of such culinary apparatus as were then available for household use.

But the progress of the adoption of these devices was chiefly among restaurants and hotels for several years, though it was not until 1904 that a European hotel became the first in the world to be equipped exclusively with electrical cooking apparatus. In England the development of the use of electricity for home cooking upon any important scale began with the introduction of the "Tricity Cooker," the introduction of which, in 1908, was successfully exploited by clever publicity campaigns, including a series of largely attended electric cooking demonstrations which started many homes in that country as users of electricity in their kitchens.

The use of electric ranges began in the United States about the same time as in England. The smaller cooking apparatus, operated by hitching on to an electric light socket, came earlier. The last few years have seen the movement toward electric cooking advance coincidently with electrical and mechanical improvement in electric ranges, until in the past year or two the demand has so grown that it seems probable that electricity will become a very strong competitor of coal, gas and other fuels in American homes.

The most serious of the technical impediments to the general adoption of electric cooking, and which for some years made it impractical for extensive adoption because of a cost prohibitive to the average consumer of heat for cookery, was that platinum, one of the costliest of metals, was the only known material which could withstand the heat needed for electric cooking. It is very seldom that the preparing of food actually needs a greater temperature than five hundred degrees (Fahrenheit), but an electric heater must be designed for much higher temperatures, because one of its greatest advantages is that it not only generates heat sufficient to accomplish its purpose, but also that it gives much quicker action and radiant heat.

Experiments were crowned with success when it was found, in 1892, that certain nickel-steel alloys would resist heat of as high as one thousand degrees (Fahrenheit) without chemical or physical deterioration of the metal, a degree of resistance which still satisfies many demands, and this material is in use in many appliances. But in 1904 nickel-chromium alloys had been evolved which will operate at a temperature reaching as high as 1750 to 2000 degrees (Fahrenheit) without injuring the material. There is scarcely any use in homes for which such temperatures are not sufficiently high, and the discovery of these nickel-chromium alloys has removed the principal technical deterrent to the general adoption of electrical heat for cooking purposes. Other substances of similar

heat-resisting properties have been discovered, but the nickel-chromium alloys are now in general use for the more modern designs of electrical cooking appliances.

Early makes of such apparatus were often found to be defective because of poor terminals and inadequate insulation, but manufacturing practice has improved greatly, and complaints of such defects are now very rare. The electric range has reached a high degree of development, and while certain changes and modifications of range construction practice are to be desired, they apply not so much to the merit of the ranges themselves as to need for uniformity and interchangeability. In other words there are many points in connection with ranges where standardization is desired. The range situation is very well known. There is a large and growing demand from consumers for ranges and appliances for cooking purposes, and this demand is based, naturally, on a process of education of the public as to the advantages which electric ranges possess over all other ways of cooking. This education it is the business of the manufacturer, who makes the ranges, and of the central station, which supplies the energy to keep the range going, to furnish. In order that such work shall be done effectually it is requisite that there should be co-ordination of objective and co-operation of endeavor between the manufacturers and the central stations. There was a widespread idea that the best way to accomplish this was by the creation of a new manufacturers' organization, but as those who would be the members of such an organization are already members of the National Electric Light Association, and a Range Committee exists in that association which has made important investigations and reports in regard to the various features of trade, production, promotion and installation of range service, it has been found an efficient medium for co-operation in the campaigns that are bringing about a constantly enlarging adoption of electrical methods for cooking.

At the Fortieth Convention of the National Electric Light Association, held in New York City in 1917, several reports were made by the Electric Range Committee of the Commercial Section and its various sub-committees, covering the subject of the condition of the industry, its growth, the means of further promotion, the obstacles to be overcome and the impediments to be removed. The reports give much valuable information about this most interesting feature of electric industry.

In this country, we glean from these reports, "the history of electric range selling by central stations dates back to 1905, when a few ranges, of design now obsolete, were on the market. A few aggressive spirits saw a future in the appliance and began the work of demonstrating to central stations the value of electric ranges as a load builder." By 1908 the interest in rates and cooking apparatus began to be shown by discussions in the National Electric Light Association *Question Box.*

Like most new departures in electricity there was at first a tendency to look upon the electric range as an electric toy, very interesting as a wonderful scientific experiment, but scarcely within range of practical things. At first even central stations in many cases found little about the idea of electrical cooking likely to add much to their business, but during the past few years the central stations have become more widely awake to this electric range service as offering a new outlet for energy sales, and a report of the sub-committee, dated March 27, 1917, on commercial information and recommendation showed that 3,964 communities had rates from their central stations which permit of the commercial use of electric ranges. These rates ranged from 5 cents down to 1½ cents per kw-hr. of which total 76.2 per cent were 4 cents or under and 31.5 per cent were 3 cents or less per kw-hr. These rates applied of course, to electric heating or cooking. The year 1916 was much larger in its electric range output than any previous year, the demand compelling several manufacturers to greatly augment their plant. The output for that year of electric ranges amounted in value to $1,500,000, but the next year it was about 100 per cent larger.

Each year increases the number of central stations which enter into active campaigns to secure electric range business. In order to make customers see it to their advantage to adopt electric cooking it is necessary, of course, first to convince them

that electric cooking has decided advantage over cooking with any other kind of fuel. In this respect much good work has been done by circulars and booklets—some issued by manufacturers of ranges and others by the Society for Electrical Development, and in the larger cities electric light companies also issue valuable catalogues, leaflets and pamphlets concerning electric ranges and all the other electrical appliances for use in the homes. Some of these larger companies also make very practical expositions of electric ranges and other electrical apparatus for the household, such as that of the New York Edison Company at the Edison Show Rooms, where experts in domestic science and able demonstrators keep busy with prospective buyers, showing them the advantages of cookery and other housekeeping work by wire.

Given a range of designated wattage, with ovens, broilers and other connections of standardized size and capacity, and it will soon be possible for the housewife to know just exactly what results come from the turning on of current within a certain time. The quality, amount and action of this ideal fuel is constant and the results are unvaried, and there is none of the haphazard dependence on an oven which is controlled by the temperature of the room, the quality of the coal, the draft of the chimney and other varying conditions that affect the ordinary range; none of the blackening of utensils, none of the dirt, heat and discomfort of cooking. The most important thing to the housewife is that it is not only the better but the easier way, releasing her from the discomforts of kitchen work and at the same time furnishing better and quicker meals. These facts known in a community, a demand is soon found.

Then comes the question of expense—purchase, upkeep, and repairs. The initial cost for purchase and installation is higher than for other fuels, and prices of ranges, like other prices, have advanced during the war period. Doubtless these higher prices deter many from undertaking electric cooking. But they have not prevented an increase of the number of new range customers every year which taxes the capacity of the manufacturers.

The thing of all others on which depends the success of campaigns for the adoption of electric ranges and water heaters in any city, is the central station rate for supplying current for such installations. Where, as in many of the states of the Great West, current is obtained cheaply because the source of the current is hydroelectric, there has been a comparatively rapid introduction of electric conveniences in the household. Small electric appliances of only occasional use, which can be attached to a lighting socket and for which current is paid for at electric light rates, have been long in use because such articles as toaster, vacuum cleaner, electric ironer, etc., consume so little current that they make little impress on the monthly bill. But a range, to cook three meals a day, or a water heater, consume a much larger amount of current, and a consumer who has been sufficiently convinced of the great desirability and superiority of electric ranges to be willing to meet the cost of purchase and installation, will frequently decide not to do so when he discovers what the monthly rate is likely to be to procure the energy to run it. Even now there are many places where the rate is not sufficiently low to encourage rapid progress in domestic adoption of electricity, though on the average there has been a very considerable progress.

As a general thing central stations have awakened quite fully to the value of the cooking load as an "off-peak" load which adds materially to the income account of the station. In many cases low rates are made for separate installation with electric ranges, and where the current is produced by water power or modern steam plants the rates are often as low as for gas.

Various statistics as to expense to consumer are published in the electric range reports (1917) of the National Electric Light Association. One central station reports an average of 90c. per person on a rate of 4 cents per kw-hr. Another makes a rate of 3 cents per kw-hr. with a minimum of $1 per month. The average rate in the entire country is now said to be a little more than three cents per kw-hr. At this rate, while the fuel expense may be slightly higher than gas in cities where the gas rate is under a dollar per 1,000 feet, there are other economies which more than counterbalance the cost difference without

taking into account the cleanliness, coolness, comfort and better food which always accompany the practice of "cooking by wire," besides many other advantages from the point of view of the consumer.

To the central station, largely because the cooking load is almost entirely an "off-peak" load, the building up of a large household clientele of range patrons means a most substantial addition to the net income. The experience of one of the central stations as reported in the Electric Range Reports of the National Electric Light Association illustrates this. The station, up to August, 1916, had installed 250 ranges. From their records the average bill for cooking and lighting in 164 range installations on which accurate data were kept was $3.97, whereas before electric cooking was introduced the average lighting bill was only $1.10, thus showing a gain in revenue, due to the range load, of 261 per cent.

A companion installation to the electric range is the electric water heater, many of which are being installed at the same kw-hr. rate and on the same circuit as the electric range. The service given on the modern electric water heater is prompt and thorough. The most improved form of electric water heater is instantaneous in effect. Water of almost any temperature up to boiling can be obtained instantaneously. Besides the advantage of instant heating, the passage of the electric current through the water acts as a germicide, and bacteria, which are contained in all waters, are reduced to a minimum.

Electricity is daily assuming greater importance in its capacity as a household servant. Beginning about a hundred years ago with the electric bell, households began about three-quarters of a century later to be electrically equipped by adopting the telephone and the incandescent lamp and the electric fan. Then in the last decade of the Nineteenth Century began the use of the various devices which are one by one revolutionizing the technique of household management, such as vacuum cleaners, electric irons and small cooking utensils for use at the dining room table (toaster, chafing-dish, samovar, coffee percolator, electric tea urn, and the like). These are all in very wide use, and among vacuum cleaners the majority are those operated by electricity.

Washing machines were among the early motor-driven appliances to be introduced into American homes. They are no longer a new thing except in the sense that they have been developed and perfected to such a high degree that they are now made in types designed for a family of two and from that to the largest family sizes. The modern types absolutely relieve wash-day from heavy work, perfectly cleansing not only ordinary garments but the finest lingerie without the slightest injury and in short time, at an energy cost of a few cents. These machines, equipped with wringers, also motor-operated, deliver the cleansed articles ready for the line. Among late developments is a machine ironer or mangle in sizes suited for household needs.

In like manner types of electric dish-washers which in larger sizes are being used successfully in large city hotels have been made in smaller sizes and especially adapted to household use. The dishes are placed in a revolving drum set in a reservoir of hot suds agitated by a paddle device. At the same time a heavy spray of hot water descends on the dishes from above, not only cleaning them but also sterilizing them. An electric motor serves both to operate this spray and the paddler and revolve the drum. The machine itself is at present rather expensive and the first cost is likely to deter families that must practice economy from investing in it, but once possessed it is not expensive to run and can be operated at a rate of about three cents per hour. Doubtless these devices will become much cheaper as the demand comes for quantity production.

There is great variety in the degree of electrical equipment to be found in modern houses. Some of the newer apartment houses in the larger cities are wired for the most extensive installation of light, heat and power. Many modern houses are planned and built with a view to the very largest use of electric current, and the most convenient architectural arrangement for such use.

The services of electricity in the home reach every part of the house. Besides

lights and the telephone, the electric fan and the vacuum cleaner, a couple of receptacles under the dining table afford connections for percolator, toaster, grill, chafing-dish, candelabra and other table appliances for general use. The modern electrically equipped kitchen has one or more outlets provided for the use of the electric iron, fan, portable electric range or fireless cooker, electric washing machine and a large number of other electric labor saving devices. Among the most useful of these are various makes of utility motor, for such activities as egg beating, dough mixing, coffee grinding, meat grinding, cleaning silver, sharpening knives, which can, indeed, be attached to almost any kitchen implement to save the housewife from many arm-wearying tasks. The sewing room of the house is greatly benefited by an electric sewing machine motor.

The bedrooms also have their appliances of novel efficiency and merit, including an electric curling iron, an electric vibrator which fills the place of an expert *masseuse,* an electric hair dryer which dries the lady's hair in a few minutes after washing it and an immersion heater for instantly warming water, make valuable additions to the list of bathroom comforts. To these may be added an electric radiator for quickly eliminating the chill from the temperature. The electric heating pad to do the work of the hot water bottle without water is a great improvement.

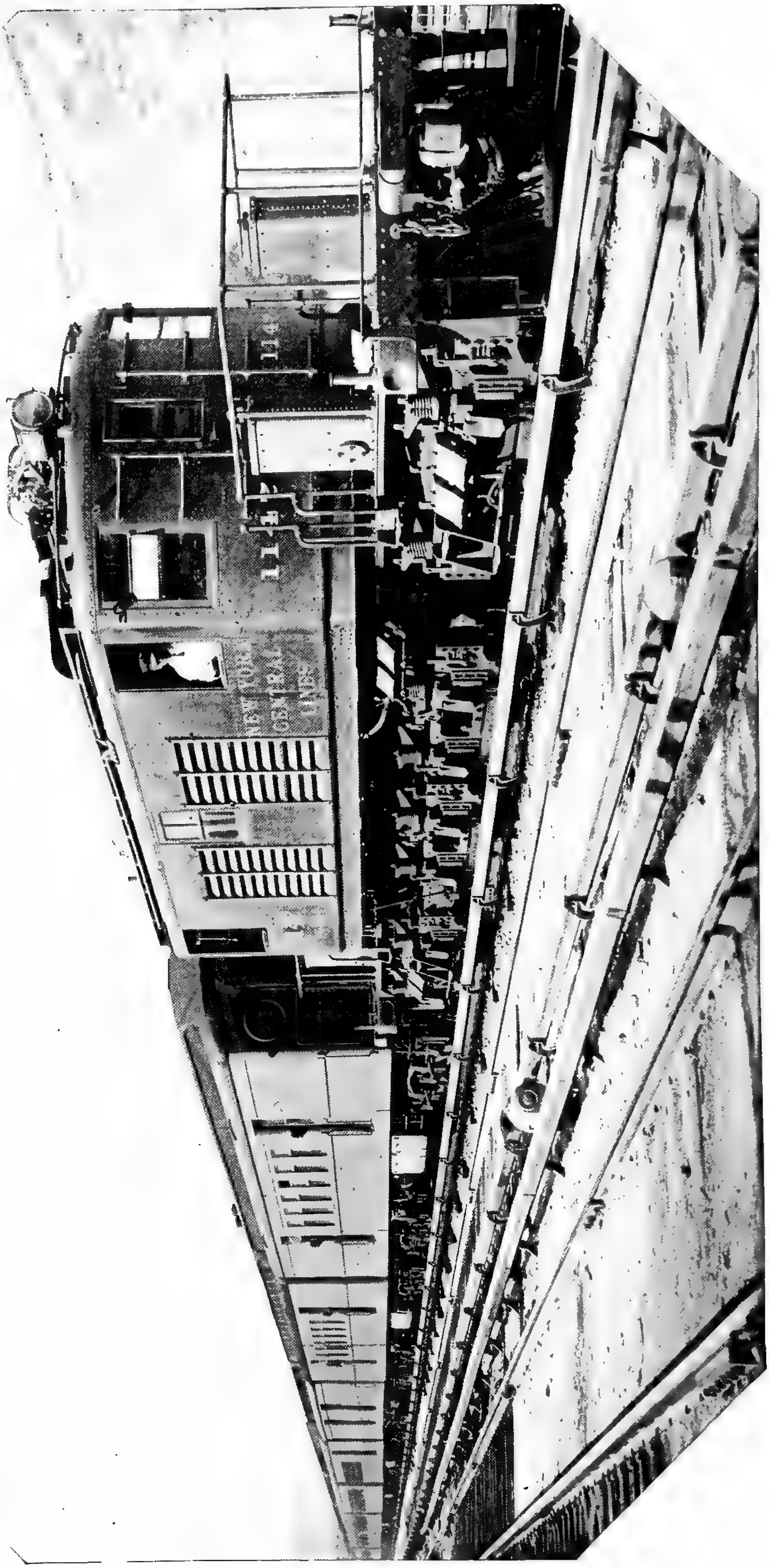
Even the baby of the house is not forgotten in the list of electric conveniences, for its interest is remembered by the electric milk warmer which does its work in the shortest possible time at any hour of the day or night by the turning of a switch.

Everything that has been said in this chapter so far has been written from the point of view of the city or suburban home which can be served by the central station. It applies also, of course, to any house which can be reached by similar service although, if it be a farm house, there will be added to what may be termed the household conveniences those of the dairy in running the separator, churn and other devices.

The owner of a farm who is in touch with modern conditions needs the service of electricity in his home as much as the city man, and has added to it the needs of the farm, which are many for many forms of motor service. If the farm is so situated that it can be done without too excessive initial expense he will do well to hitch up to a central station for his electrical service.

But for those not so favorably located with respect to service lines, there have been created means for the installation of small isolated plants which perform very efficient work in lighting the home and doing a vast number of things that can be accomplished by the use of a small motor.

Several large manufacturers of electric appliances have placed on the market complete electric light outfits which are intended to be used in the generation of electricity for light or power, such as is needed in and about the house, barns or other parts of a farm. The use is required of an oil or gasoline engine, water wheel or other means of driving a generator which is used for charging batteries. By these outfits of varied capacities to suit the individual needs, the farm house may be sufficiently equipped for all desired electrical conveniences, and country homes of any kind are made to furnish all the comforts that electricity can provide for the city home. While the connection with the central station is better where it can be had, the farm or country house can find in the electric outfits made for isolated places a great labor saving convenience. The work of the housewife in the country home or farm house is more burdensome than in the city home or apartment, and there is all the more need there for taking the heavy load from her arms and shoulders and carrying it by wire; and in the case of the farm, there is also a great reduction in the farm labor itself by using electrical equipment.



New York Central Electric Locomotive Hauling a Twelve Car Train

CHAPTER XI

STEAM RAILROAD ELECTRIFICATION IN THE UNITED STATES

AFTER a business has been conducted along certain standard lines for a number of years, any changes requiring the introduction of new conditions are viewed more or less with disfavor.

This was the situation the railroads had confronting them, when it was first proposed to substitute electric operation for steam operation.

The pioneer work of electrifying steam roads was not due to any economic gains, but was done principally to overcome certain conditions that existed in steam operation, and which had to be eliminated.

Thus the Baltimore & Ohio, New York, New Haven & Hartford and New York Central Railroads were forced into electric operation in order that the smoke and gas nuisances might be abolished in the tunnels on their respective roads.

When the successful operation of trains by electricity had become assured, other railroads took up the matter of electrification in order that large terminals might be built and facilities be increased, which only could be undertaken by utilizing some motive power other than steam. In such a class would come the New York Terminal of the Pennsylvania Railroad and the Michigan Central Terminal and Connections in Detroit, where trains have to pass under the Detroit River.

The handling of heavy trains over grades through Mountain Divisions was next considered, and it was found that in addition to hauling heavier trains, with electric locomotives, the running time could be decreased, thereby showing a marked saving, reducing the consumption of coal and increasing the track capacity of the road.

The fact of being able to brake the trains with electric locomotives, as well as haul them, immediately presented itself, making this feature one of the most important on such mountain grades. The Norfolk & Western installation comes under this class, as well as the installation of the Chicago, Milwaukee & St. Paul Road. This system has been able to utilize the necessary electric current from hydraulic power plants driven by the mountain streams.

The saving in coal by this road on one of its divisions each year is estimated to be more than 200,000 tons. This saving of coal if utilized for ocean steamers, would handle 90 steamers of 13,000 tons displacement, to carry supplies from New York to France.

On another division of this road the consumption of oil for oil-burning locomotives was formerly 425,000 barrels per year. This amount of oil is now available for other purposes.

The electrification of Branch Lines in connection with the Main Lines has become a very important factor with some of the roads.

The saving that can be obtained by elec-

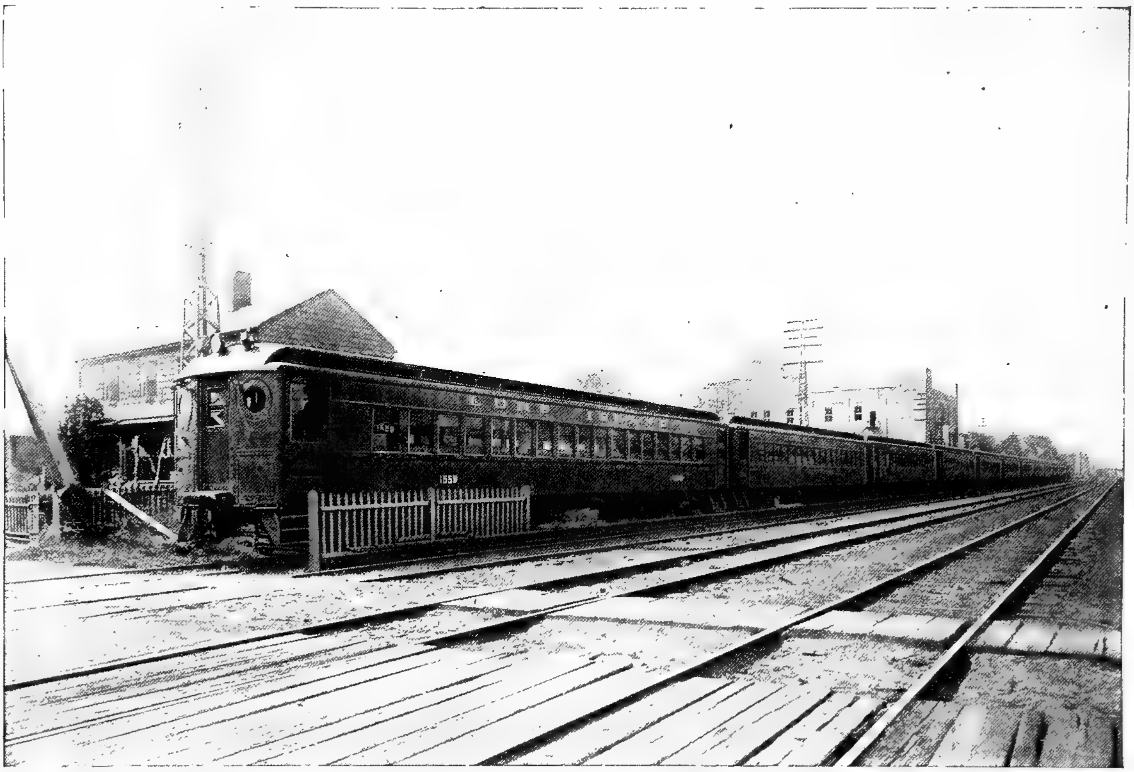
trifying large freight terminals is most satisfying.

It has been demonstrated that three electric locomotives can replace seven steam locomotives, and perform the same work without causing any complaint of the smoke nuisance from residential or industrial sections in which such terminal plants are located. The principal saving is brought about by the fact that an electric locomotive can work every hour of the twenty-four, without stopping to be coaled, tanks filled with water or the cleaning of fires which was formerly necessary when steam engines were used in switching service.

The use of electricity as a motive power for operating trains on steam roads dates back to the first installation of this nature in the year 1895, at which time the Baltimore & Ohio Railroad electrified seven and one-half miles of single track, for 650 volt direct current, which covered three miles of route track through the Baltimore Tunnel.

Six locomotives were used through this tunnel, to pull trains, for the purpose of eliminating the gases and smoke due to the steam engines.

The operation of electric locomotives on the Baltimore & Ohio proved fairly successful, although a number of defects developed due to the newness of this form of electric application.



An Eleven Car Multiple-Unit Motor Car Train on the Long Island Railroad, Each Car of Which Is Equipped With Two Motors and Unit Switch Control

One of the first steam lines to take up the operation of its trains by electricity was the Long Island Railroad, which inaugurated electric service on some of its branches in 1905.

At the present time it has approximately 200 miles of electrified track, over which are operated two hundred or more trains per day, a number of these trains running in and out of the Pennsylvania Station in the City of New York.

The Long Island Railroad adopted the

650 volt D. C. third rail system, and its equipment in the electric service consists of cars electrically equipped and designed to operate a multiple unit service.

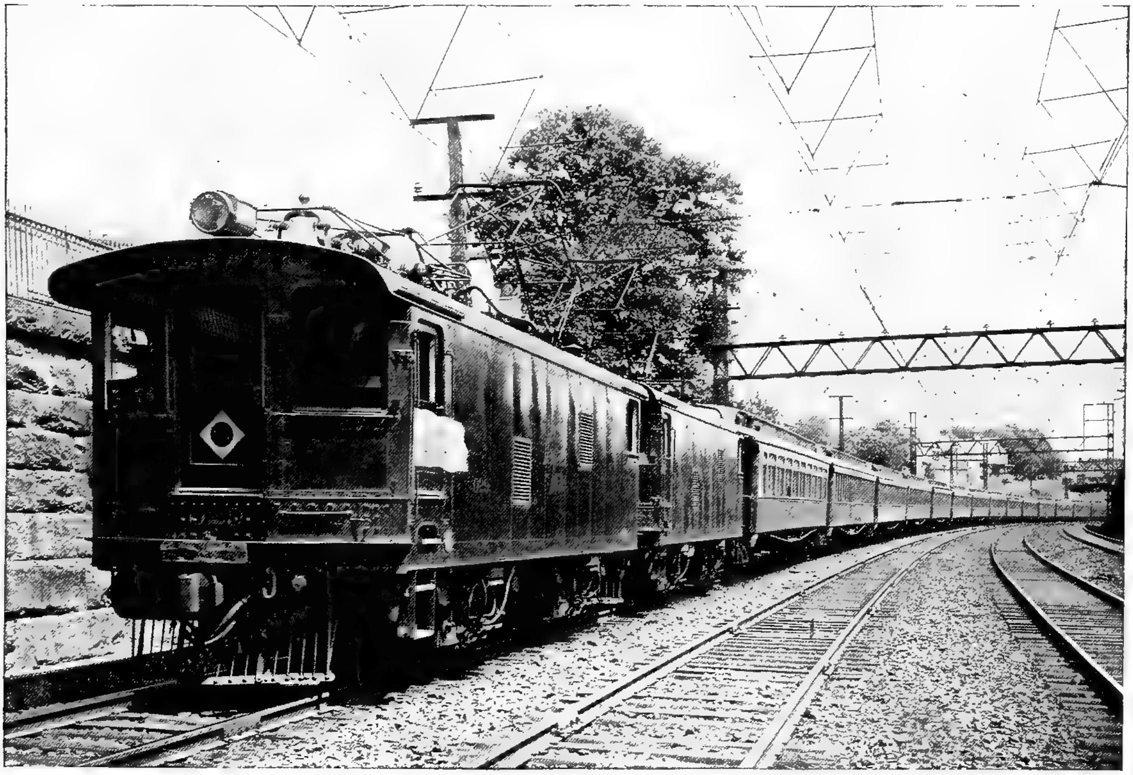
The Act of Legislature of May 7th, 1903, of the State of New York provided certain regulations for the terminals on the New York & Harlem Railroad, and by this Act the New York Central & Hudson River Railroad and the New York, New Haven & Hartford Railroad were required to "run their trains by Electricity" or by some motive power other than steam over certain tracks and through the tunnels approaching Grand Central Station.

The Act required the change of motive power on or before July 1st, 1908.

To meet the order in the City of New York, various forms of motive power were considered, and it was decided that electrically operated trains would best meet the conditions. An infinite amount of study and experiment became necessary.

The New York, New Haven & Hartford Railroad, which uses the New York Central Company's tracks from Woodlawn to Grand Central Terminal, a distance of twelve miles, arranged its plans and adopted a system that would ultimately enable it to operate trains on its main trunk lines through to Boston, a distance of 229 miles. The first step consisted in equipping the main line between Stamford and Woodlawn with an overhead single phase alternating current trolley system and then utilizing the third rail direct current system of the New York Central Company from Woodlawn to Grand Central Terminal. This work was started in 1905.

Next the Harlem River Branch, a six-track road, extending from New Rochelle Junction to Harlem River Station, a distance of 11½ route miles, was electrified, together with its freight yards at Westchester, Oak Point and Harlem River,



Trains on the New York, New Haven & Hartford Railroad Which Uses the Tracks of the New York Central Company into the Grand Central Station at New York

these yards having a track mileage of 15, 40 and 20 miles respectively.

The main line from Stamford to New Haven was next electrically equipped, giving a main line of 73 route miles electrically operated, with a total of 550 track miles over which electric trains operate and, together with its yards, makes a total of approximately 700 miles. All this is alternating current.

The New York Central Company adopted that method known as the third rail, 650 volt d. c. system and electrified that portion of their tracks from a short distance beyond Woodlawn to Grand Central Terminal—a distance of approximately 15 miles. The work which was started in 1906 has since been extended to Harmon, a distance of 33 miles from New York City on the main line to Albany.

The adoption of electricity as a motive power by these two railroads was the first steam road electrification of any magnitude that was attempted and was brought about principally with the idea of overcoming the gases and smoke in the tunnel. The idea of economic gains was at first less significant.

A study of the results of operation demonstrated that there were a great many benefits that could be made which at first did not appeal to the railroads. In addition to eliminating gases and smoke in the tunnels which caused great discomfort to the passengers, the hazard of operating trains through the tunnel due to the inability of the engineers to see the signals was done away with and a greater number of trains could be run through the tunnel in a given time than when formerly operated with steam.

Six Trunk-Line Section of the New Haven Railroad, Illustrating the Overhead Construction

The elimination of smoke and gases also immediately presented the opportunity to use one or more levels for the loading and unloading of trains in the Station, thereby utilizing space valuable in a terminal such as the Grand Central.

The problems of disposing of the ashes,

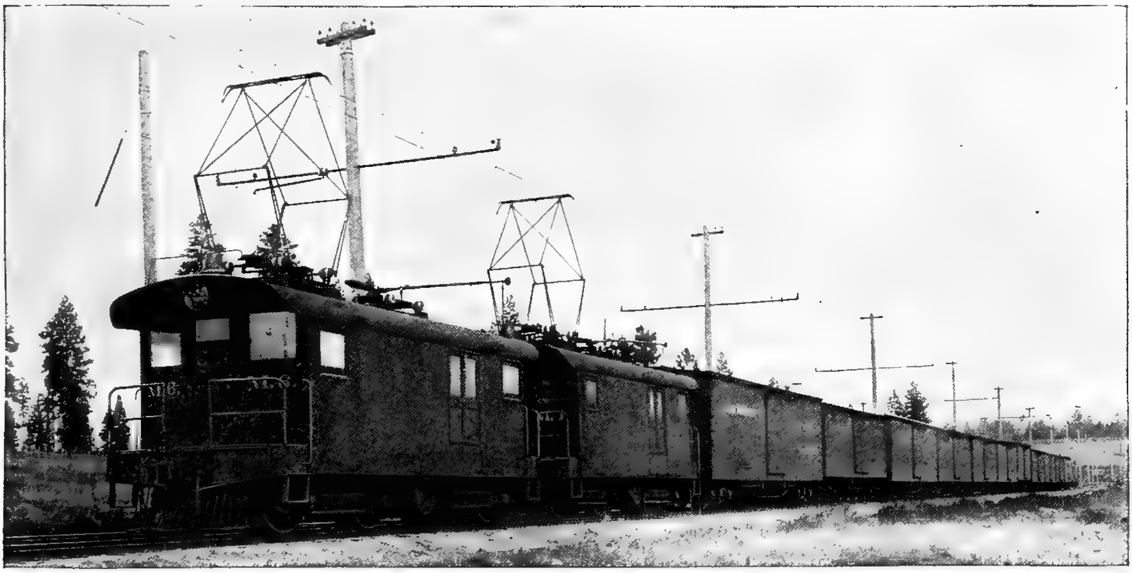
filling the tanks with water and cleaning the fires that had been experienced with the steam locomotives were entirely done away with, in addition to the saving in time. Moreover, with electric locomotives, the locomotive was available for service for another train as soon as the passengers could be discharged from the train it brought in, and these quick turns with electric locomotives reduced the number of locomotives required for the trains running in and out of Grand Central Terminal about one-half.

In 1906 the Spokane & Inland Railroad, which serves the country in a region of the Northwest, was built and electrified for 6,600 volts, single phase, and from time to time extended until it now covers 186 miles of route.

This road, in addition to its passenger service, operates a freight service extending into the grain country, and, due to the flexibility of the system, the electrically operated freight locomotives closely approximate a ton mileage of 3,000,000 per month.

The electrification of this road was brought about by the economies that could be obtained from the use of electricity generated in hydraulic plants located in that vicinity, and also on account of the scarcity of coal. Also, when operating with steam locomotives at an extremely low temperature the efficiency of the steam engine decreased very rapidly, whereas, when operating with an electric locomotive, the efficiency increased, due to the fact that the rating of an electric locomotive is based on the temperature.

The Erie Railroad on its Rochester Division electrified for 11,000 volts, single phase, in 1907, having 34 route miles and extending between Rochester and Mount Morris. This branch line was electrified for economic purposes, it having been estimated and afterwards proven that electric operation resulted in an increase of 50% in the passenger travel, with a considerable saving in roundhouse and other expenses incidental to steam operation.



Freight Train on the Spokane & Inland Empire Railroad Drawn by Two Fifty-two Baldwin-Westinghouse Locomotives

Prior to 1908 the Grand Trunk Railway investigated the advisability of electrifying with 3,300 volts, single phase, system the St. Clair tunnel, which connects the town of Port Huron, Michigan, with Sarnia, Ontario, by passing under the St. Clair River.

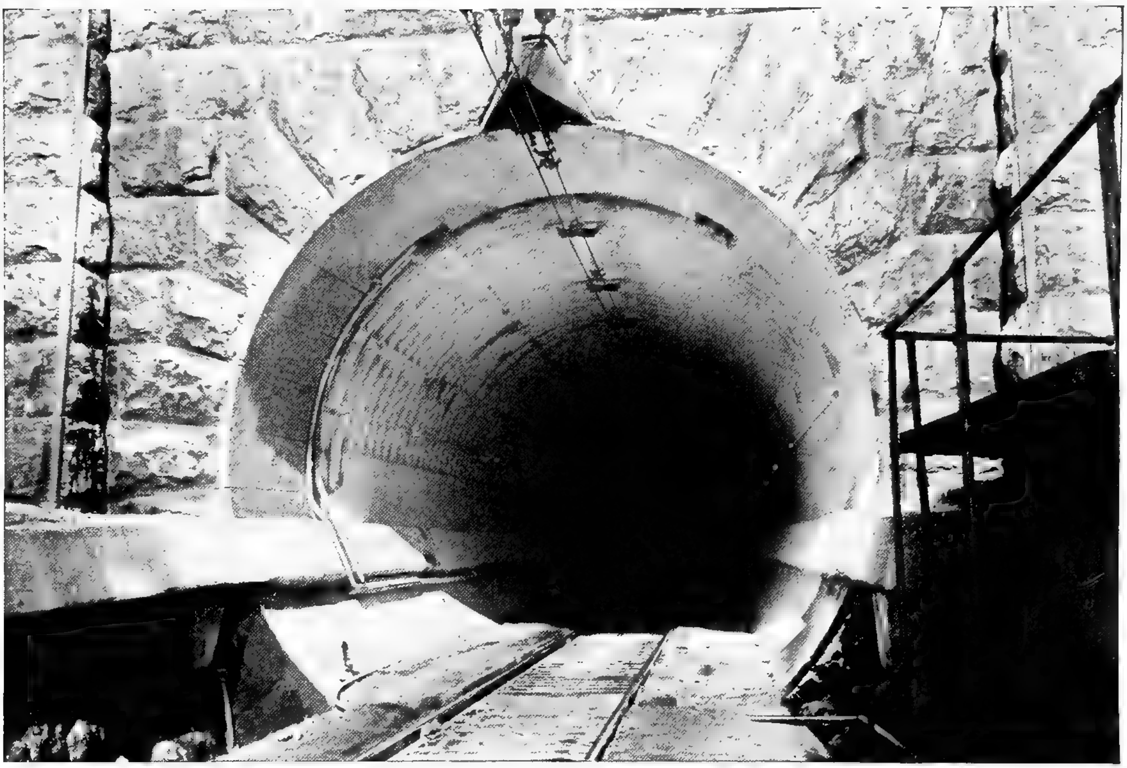
The gases and smoke limited the operation of trains which moved through this tunnel, and the operation of steam locomo-

tives on the heavy grades at the approaches to the tunnel was more or less inefficient.

In 1908 electric service was inaugurated, which resulted in the elimination of the trouble experienced in the past as to smoke and gases, and, in addition, the electric locomotives were built to negotiate the grades without loss of time or stalling. This application of electricity has been one of the most successful from all standpoints of any steam railroad electrification.

The Maryland Electric Railway, which is known as the Annapolis Short Line and which extends from Baltimore to Annapolis, Md., has a route mileage of 25 miles and was one of the first of the steam roads located in the South to fully realize the possibilities of electrification. This road, which is one of the oldest in the South, decided to change to electrically operated trains, using 1,200 volt direct current system, taking its current from trolley wires. Electric service was inaugurated in May, 1908.

When formerly operated with steam, comparatively a small amount of business was done over this road, but since changed to electric operation, thereby giving a reliable and pleasant service, the property has been developed to such an extent as to make the shore front an attractive location for a large residential population.



The St. Clair Tunnel on the Grand Trunk Railway Between Sarnia, Ontario, and Port Huron, Michigan, Forty Feet Below the St. Clair River, Whitewashed and Lighted by Electricity

In 1909 the Pennsylvania Railroad, having built and equipped its terminal in the City of New York, inaugurated its electrically operated train service, using 650 volts d. c. system.

The electrification of this terminal was an important factor in the successful solution of the Pennsylvania problems, as it made it possible for the use of tube tunnels under both the North River and the East River, thereby forming a physical connection between the Long Island Rail-

road on Long Island and the main line in New Jersey.

By eliminating the steam engine in this terminal, the noise, smoke and gases, also fire dangers, have been entirely done away with, and the 500 trains that are handled through this terminal daily are electrically operated, using electric locomotives to convey trains from New York City to Manhattan Transfer, N. J., and using multiple unit cars for operation from the Pennsylvania Terminal to the Long Island Railroad.

river, which was to be electrically operated, thereby doing away with the objectionable delays due to the ferrying of trains.

Such a tunnel was built and electric operation inaugurated in 1910, using the 650 volts d. c. current third rail system, there being 19½ miles of single track electrically equipped.

The Rock Island and Southern Railroad in 1910 electrified 78 miles of single track, adopting the 11,000 volt single phase system, with the idea of developing the re-

An Electric Train on the Pennsylvania Railroad Entering the New York City Terminal of that Company

The Pennsylvania Railroad has a total of 132 miles of single track electrified in connection with this installation.

The electrification of a section of the Michigan Central Railroad was authorized, to overcome the difficulty of ferrying trains across the Detroit River from the Canadian shores to the City of Detroit, on account of the ice in the river obstructing the passage of the ferryboats.

After the successful application of electrically operated trains on other roads, it was decided to build a tunnel under the

sources of the territory through which this line passes, thereby reaching the stock yards, grain elevators and new towns which were springing up along its route.

The physical conditions of this electrification made possible the location of the power house in the center of the electrified zone and by the use of a 11,000 volt single phase system no feeders or sub-stations are required. The operating results show a good return on the investment. In addition to establishing a reliable service, it

not only provides a good passenger schedule but also permits of quick delivery of way-freight material.

The Boston & Maine Railroad built the famous Hoosac Tunnel in 1875, which is located just east of North Adams on its main line. This long tunnel formed a very serious obstruction to the operation of its trains due to the accumulation of smoke and gases, and it was necessary to hold trains at each end of the tunnel for a considerable length of time in order to allow the tunnel to clear itself of smoke, etc.

The New York, Westchester & Boston Railway, which is strictly a suburban service, had the advantage when building its road of laying it out with only the idea of electrically operating the track, and its whole construction had in mind only electrically propelled trains.

The service is the same as that which would be operated under steam operating conditions, and it directly connects White Plains, New Rochelle and Mt. Vernon with the Third Avenue Elevated system in New York City.

Typical Passenger Train in Electric Operation at Hoosac Tunnel. The Steam Locomotives Are Hauled Through with Banked Fires. Three Trains in Each Direction Are Now Allowed in the Tunnel

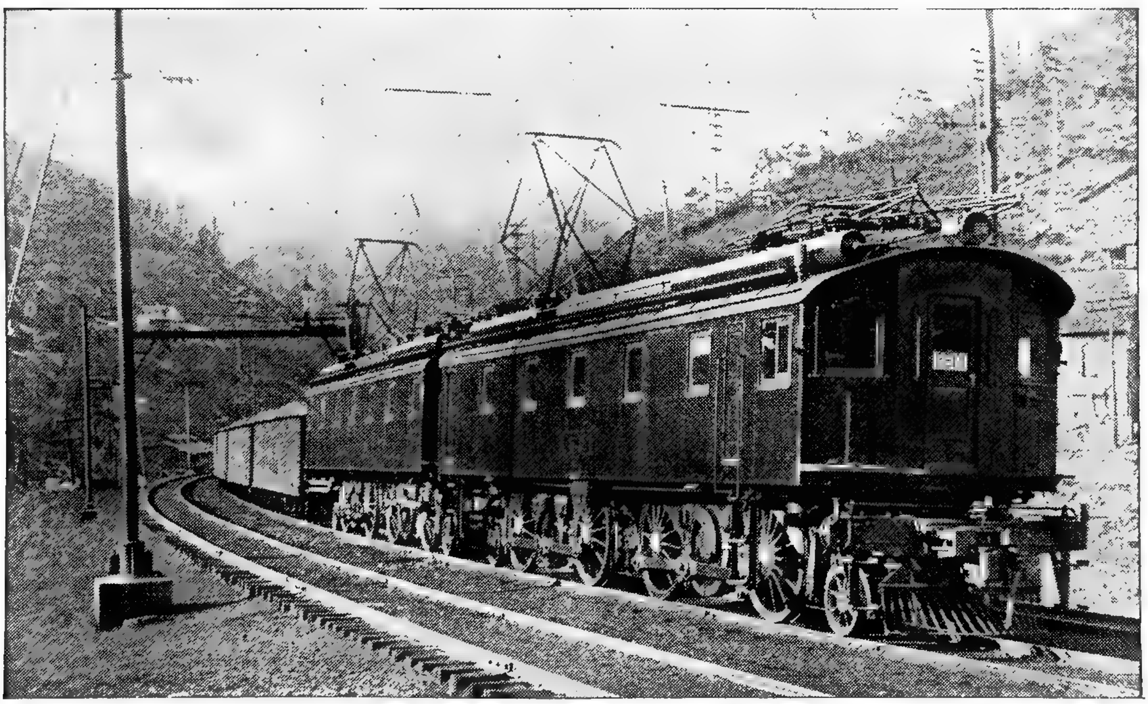
The conditions under which it was necessary at times to operate through this tunnel, although having double tracks, made it necessary to issue an order to allow only one train at a time to pass through the tunnel during the period of steam operation.

It was decided to electrify, using 11,000 volts single phase system for this tunnel, to do away with these objections, and in 1911 electric operation was inaugurated, and the results obtained were even greater than had been expected. The miles of single track electrified on this system are 22.

The system adopted was the same as the New York, New Haven & Hartford R. R. Co., namely 11,000 volts, single phase alternating, using overhead contact wires, and 49 miles of route track have been equipped—the service being inaugurated in 1913.

The Norfolk & Western Railroad electrified that section of its system known as the Elkhorn Grade, in order to obtain an increase in the capacity of the existing tracks, also increased speed in hauling heavy trains, thereby eliminating the congestion of trains on that section of their

High Speed Car Employed by the New York, Westchester & Boston Railway in Its Suburban Service



Train Descending the Elkhorn Grade on Norfolk & Western Railroad. The Front Locomotive Automatically Holds the Entire Train by Means of Electric Regeneration Without Use of the Air Brakes

tracks—at the same time doing away with the delays caused by coaling and watering steam engines.

The substitution of electricity also contemplated the reduction of unusual operating expenses caused by additional maintenance crews, etc. Thirty miles of main line covering 85 miles of single track were electrified, using the 11,000 volt single phase system; and electric service was inaugurated in 1914.

The handling of heavily laden coal trains down the grade was almost as great a factor as hauling the trains up the grade. Thus, by utilizing electric current for regeneration in the electric locomotives, a train is held and speed regulated without the use of air brakes — the air not being used at all but simply maintained as an emergency feature.

In 1915 the Pennsylvania Railroad inaugurated electric operation on its Paoli Division, which has its terminus in the Broad Street Station at Philadelphia, Pa. This electric installation covered the suburban service and was brought about by the fact that six suburban routes met at the entrance of the Broad Street Station Yard. The congestion consequent on the arrival of these trains through the throat of the yard was very serious and the track capacity of the Broad Street Station having been reached, it was found that only by electrifying the lines could the conditions be remedied.

With steam operation, it was necessary, after having unloaded passengers, to back the train out of the station, turn the engine, renew the coal and water supply and then make up the train and back it into the station for outgoing service. With electrically operated trains, all shifting and turning of trains was done away with, the train being ready to receive a load of passengers for outgoing service as soon as the incoming load could be discharged.

A Section of the Line Construction of the Philadelphia-Paoli Electrification on the Pennsylvania Railroad

The Paoli Division has 100 route miles of track electrified and the Chestnut Hill Branch 50 miles, and this suburban service is taken care of with trains operated in multiple unit service.

The Chicago, Milwaukee & St. Paul Railroad considered substituting electric operation over certain of its Divisions with special reference to that part of the line that passes over the Great Divide,

with the idea of overcoming the loss of time that was necessary when steam operation was used.

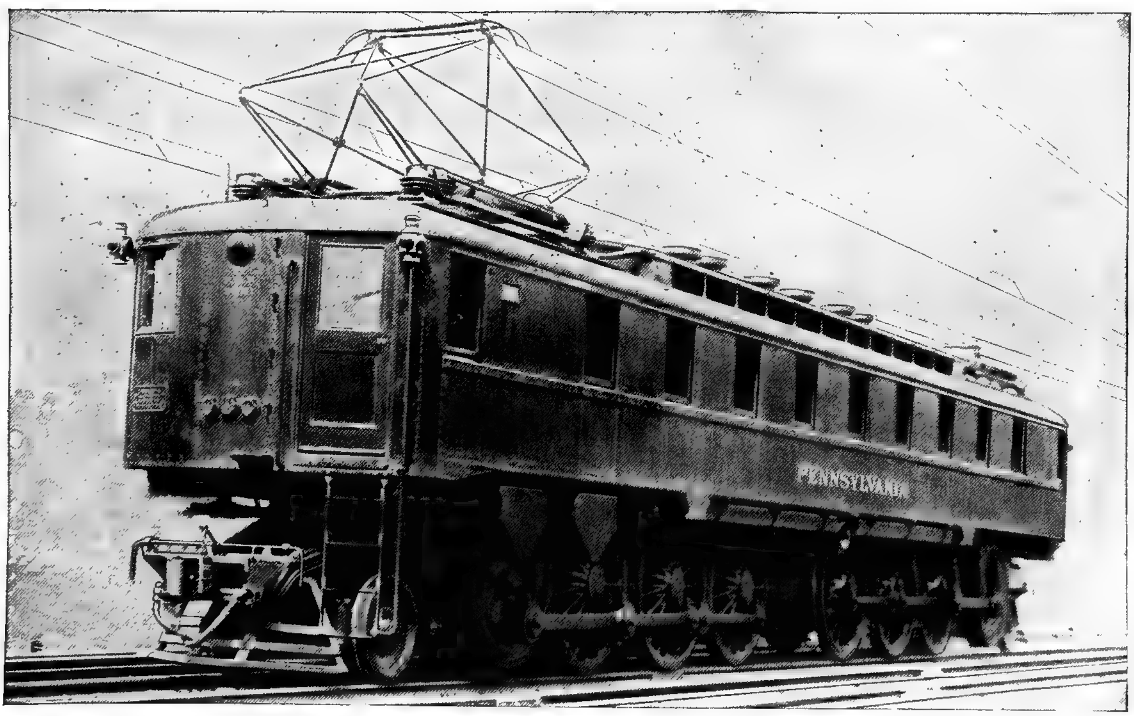
The Rocky Mountain Division was electrified with energy derived from adjacent waterpowers, and electrical operation was started in April, 1916.

Similar operation was inaugurated on the Missoula Division in 1917. This road has at present 588 miles of single track electrified, with a route mileage of 438 miles.

The distributing system consists of two overhead contact wires having an initial voltage of 3,000 volts d. c. The current is collected from the contact wires by means of pantagraph shoes of the sliding type.

ELECTRIFIED STEAM RAILROADS IN THE UNITED STATES

	Date	Miles of Single Track	Miles of Route	Locomotives	Cars
Baltimore & Ohio R. R.	1895	7½	3	6	...
N. Y., N. H. & H. R.R.	1905	550	88	100	70
Long Island R. R.	1905	250	100	...	509
N. Y. Central R. R.	1906	235	53	61	200
Erie Railroad	1907	40	34	...	8
Annapolis Short Line	1908	30	25	...	12
Grand Trunk Railway	1908	12	3½	6	...
Great Northern R. R.	1909	6	6	4	...
New York Terminal—Pennsylvania R. R.	1910	132	20	33	8
Rock Island Southern Railway	1910	78	50	2	6
Michigan Central R. R.	1910	19½	4	10	...
Boston & Maine	1911	22	8	6	...
Norfolk & Western R. R.	1914	85	30	12	...
Philadelphia Terminal—Pennsylvania R. R.	1914	90	20	33	...
Chicago, Milwaukee & St. Paul	1916	588	438	44	...
Paoli Div., Pennsylvania R. R.	1915	150	...	...	120
N. Y., Westchester & Boston R. R.	1913	50	16.2	2	49



The Most Powerful Electric Locomotive in the World, 7,000 H.P. Built by the Westinghouse Company for the Pennsylvania Railroad Company's Altoona Grade Electrification

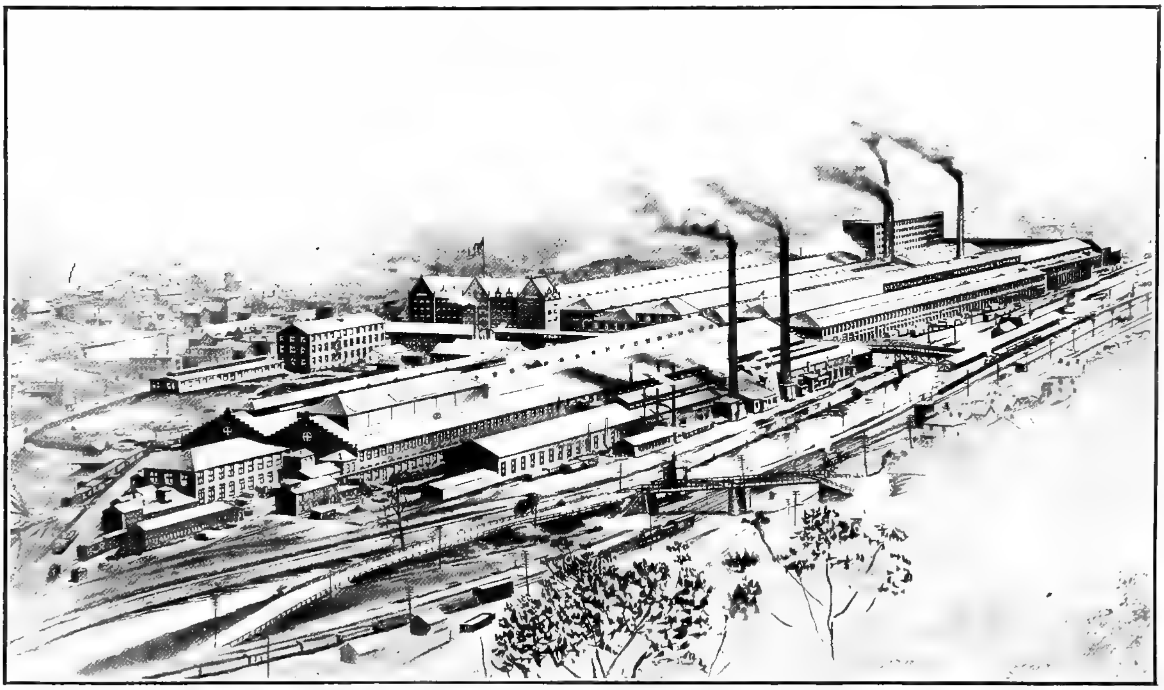
THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY

The Westinghouse Electric Company was founded in 1886, not simply to be a competitor of the electrical concerns then in existence, but to be the means of transforming into reality a vision of the future.

In 1884 electrical progress was well under way. Several central stations and private plants were in operation, and the immense possibilities that lay in the new power were beginning to be dimly apparent. But, while engineers were familiar with both direct current and alternating current, direct current alone was considered commercially useful, alternating current being regarded as a scientific curiosity applicable to a few minor purposes only.

At this time, George Westinghouse, who had already organized the Westinghouse Air Brake Co., the Westinghouse Machine Co. and the Union Switch & Signal Co., was abroad on business connected with his air brake. While there, his attention was called to the Gaulard & Gibbs system of distributing alternating current, with its remarkable transformers that could raise or lower voltage any desired amount by the use of simple, motionless coils.

The relation between voltage and the distance through which electricity can be economically transmitted was already understood, and since 230 volts was then believed to be about the highest voltage feasible with direct current, the general concensus of opinion was that the distribution of electric energy was restricted to distances of a few thousand feet. But Mr. Westinghouse realized that alternating current, with its easy voltage transformations, transcended all limitations of distance. His imagination saw the cataract in the wilderness lighting cities hundreds of miles away, and inspired by a faith in which he never faltered, he bought the Gaulard & Gibbs patents, and on his return to America organized the Westinghouse Electric Company to develop what he felt to be the true power of the future.



East Pittsburgh, Pa., Works of Westinghouse Electric & Manufacturing Company

The new system was brought rapidly into practical shape. By October, 1886, 300 incandescent lamps were kept lighted by alternating current transmitted over

two miles at 1000 volts. Shortly afterwards a complete plant was installed at Greensburg, Pa., and the history of both alternating current and the Westinghouse Electric Company was fairly begun.

At first it appeared that alternating current was to be useful for lighting only. Attempts had been made to devise a satisfactory alternating-current motor, but the problem seemed insoluble except at the cost of excessive complication. But in 1888, Nikola Tesla brought forth his polyphase alternating-current motor. He was promptly associated with the company, and when his invention was perfected it greatly extended the usefulness of the new power. In the meantime Shallenberger devised his alternating-current meter, so that the Westinghouse Company now had in hand all the elements for the application of alternating current in every field, and proceeded to develop it vigorously.

The early years of alternating current were, however, anything but peaceful. The advocates of direct current attacked it with every weapon they could grasp. But no obstacles could arrest its growth, and disclosures of real weaknesses resulted only in correction and perfection. Finally, when the Westinghouse Company secured the contract for lighting the Chicago World's Fair, and when in the following year it supplied the equipment for the famous Niagara Falls power plant, opposition became hopeless and ceased. Alternating current was acknowledged to be an invaluable supplement to direct current and all the larger companies began the manufacture of apparatus for both systems. Today over 75 per cent of all electric current generated is alternating.

The Niagara Falls installation gained for the Westinghouse Electric & Mfg. Co. (which had succeeded the Westinghouse Electric Co. in 1891) recognition as one of the foremost electrical companies of the world. Thereafter its history is not narrowly confined to a single line, but branches out into practically every field where electric current can be used, and much of the marvelous electrical progress of the past 25 years has been due to the achievements of this company. Some of the more important of these achievements can be mentioned, but they form only a small part of the Westinghouse record.

THE GENERATION OF ELECTRICITY

Prior to 1899 steam engines for driving electric generators were always of the reciprocating type. The genius of Watt had given this type to the world and for over a century mechanical science and skill had been improving and refining it until the last word in steam engine construction seemed to have been spoken.

But it was not in George Westinghouse to remain contented with things as they are, no matter how perfect they appeared to be. He was always working forward, years ahead of his time; always seeking something better than the best that was being produced. So when Charles Parsons brought out in England a new type of engine, the turbine, Mr. Westinghouse investigated it with care and, seeing in it some points of superiority over the reciprocating engine, bought the right to manufacture it and, characteristically, started in to redesign it from the ground up.

In 1899 the first turbine generators in America were installed in the power house of the Westinghouse Air Brake Co., Wilmerding, Pa. That was not twenty years ago, and yet within that short space of time this new type of prime mover has not only won supremacy over the reciprocating engine, but has well-nigh swept its venerable rival out of existence.

In this work of revolutionizing the generation of electric power the Westinghouse Electric & Mfg. Co. and the Westinghouse Machine Co. (now controlled by the Electric Co.) co-operated. Together they brought the turbine-generator to a high state of efficiency and then began to construct units of hitherto unheard-of capacities. In 1904 the 6700 horsepower Westinghouse generators of Interborough Rapid Transit Co. were conceded to be about the largest that could be driven by reciprocating engines. Today the Westinghouse Co. is engaged in building an 80,000 horsepower turbine generator for this same company.

Nor has the other end of the scale been neglected. Until recently it was thought that turbines smaller than 100 horsepower or so were not practical, but the Westinghouse Company proved the error of this opinion by building efficient turbines as small as 5 horsepower.

ELECTRIC RAILWAYS

The rapid spread of electric street railways throughout the country is one of the most striking events in the history of electrical progress. Twenty years after the first electric street car crawled up the hills of Richmond, Va., there was a street railway system in practically every community of the United States that could support one. Obviously such a record could not have been made unless satisfactory and efficient equipment was available.

In the design and construction of electric railway apparatus the Westinghouse Electric & Mfg. Co. played a prominent part from the beginning. It was, indeed, this company that solved one of the most difficult problems first encountered, by originating that type of motor that has ever since been universally used for street car service. Since then, its contributions to electric railroading have been literally too numerous even to list, but special mention should be made of the electro-pneumatic system of control that enables a motorman to handle a whole train of motor cars as easily as a single car.

The work of furnishing the people of the United States with rapid transit can be regarded as finished except for supplying the needs of the ever-increasing population. But an even greater work still remains to be done; namely, the electrification of the American steam railroads. No one expects that all our railroads will be electrified, but beyond doubt many of the readers of this book will live to travel from Boston to Richmond or to Chicago on trains drawn the entire distance by electricity.

A start in this direction has already been made. The electrified mileage today is, it is true, relatively insignificant, but enough

Equipping Electric Locomotives in the Westinghouse Works

has been done to convince both electrical engineers and railroad men that the problems in electrification have been solved, that all operating conditions have been successfully met, and that general electrification now depends solely on commercial, and not on electrical, considerations.

The present position of the Westinghouse Electric & Mfg. Co. in the electric railroad field is one of supremacy. Not only has it electrified more miles of track than any other company in the world, but it has installed more different kinds of systems and its locomotives haul greater tonnage. The following are some of its more noteworthy electrifications:

New York, New Haven & Hartford Railroad.—This is the most comprehensive electrification that has yet been made. All types of trains—express, local and freight—are operated electrically between New York City and New Haven, Conn. The trains receive 11,000-volt single-phase alternating current between New York City and New Haven, and run into New York City on 600-volt direct current.

Norfolk & Western Railroad.—Over a mountain division of this road is carried the heaviest tonnage hauled by electricity in the world. Three of the largest steam locomotives were previously used for each train, but they proved inadequate to handle the traffic over the steep grades and through the long tunnels. Baldwin-Westinghouse locomotives now haul longer trains at twice the former speed so that the capacity of the division has been doubled. Alternating current, distributed at 11,000 volts, single-phase and transformed on the locomotive into 440-volt, three-phase, is used on this road.

Pennsylvania Railroad, New York Terminal. — Locomotives of 4,000 horsepower receive the long steel passenger trains at Manhattan Junction and haul them under the Hudson River into the Pennsylvania Station. The 33 locomotives in service have traveled over five million miles to date and have had an almost perfect record in maintaining their schedules. One of these locomotives received the Grand Prize (highest award) at the Panama-Pacific Exposition.

Pennsylvania Railroad, Paoli Division.—A 20-mile stretch from Philadelphia to Paoli has been electrified in order to relieve the congestion at Broad Street Station. Three hundred local suburban trains are operated by 11,000-volt single phase, alternating current. The Chestnut Hill branch is now being electrified.

Long Island Railroad.—This line carries the heaviest suburban traffic of any American railroad. Electric trains are operated from New York City, under the East River, and from Brooklyn throughout the thickly populated districts of the island. Six hundred-volt direct current is used.

INDUSTRIAL POWER

In the early days there were no specialized motors for industrial power purposes, each manufacturer building but one or two types which were used for all applications. What was chiefly wanted was something that would go round, and the motor that could do this without excessive fireworks and lengthy visits to the repair shop was considered a good motor.

But a little experience in the design and construction of motors soon demonstrated that the motor was the most pliant of machines. Its speed and power characteristics could be varied over a very wide range and its mechanical structure could assume almost any desired form. Since almost every kind of machine used in the industries has its own peculiar characteristics, the advantages of making a motor to suit each machine soon became apparent.

Seeing a wide field for research here, the Westinghouse Company made a careful study of all the machines used in the industries—machine tools, wood working machinery, steel mills, pumps, elevators, hoists, textile machinery, printing presses, laundry machines, ventilating apparatus, sewing machines and a hundred more—to determine just what kind of motors and controllers were best adapted for each. As a result, a large number of special motors and controllers were designed, each for a particular purpose, and the rapid extension of motor drive into every branch of industry shows how successful this policy has been. Today the largest motors in existence—of 15,000 horsepower for steel mill drive—are of Westinghouse make.

OTHER ACTIVITIES

There are many other chapters of the Westinghouse Company's history that deserve special mention—such as the classic investigation on lightning and lightning arresters, the development of the watthour meter and the perfection of the geared drive for ships—but space does not permit. The following very incomplete list of some of the company's products may, however, indicate the extent of its activities:

For Generating Power
- Steam turbines
- Condensers
- Stokers
- Gas engines and producers

For Distributing and Measuring Power
- Switchboards
- Switches
- Circuit breakers
- Meters
- Transformers
- Rotary converters
- Rectifiers
- Motor generator sets
- Lightning arresters
- Line material
- Insulation

For Utilizing Power
- Locomotives
- Railway equipment
- Motors
- Controllers
- Ventillating outfits
- Electric vehicle equipment
- Moving picture apparatus
- Refrigerating machines
- Welding outfits
- Sewing machine motors
- Electric irons
- Heating appliances
- Ranges
- Lamps
- Fans

PHYSICAL GROWTH

In 1886 the Westinghouse Electric Company started in Garrison Alley, Pittsburgh, Pa., with 200 men and less than 50,000 square feet of floor space. In 1891 it absorbed the U. S. Electric Light Co. and the Consolidated Electric Co., and in 1895 the shops were moved to what is now East Pittsburgh, where they had a floor space of about 12 acres and employed about 3,000 people.

Today the company, with its subsidiary and controlled companies, occupies floor space exceeding 90 acres, employs nearly 30,000 people and ships as high as 1,200 carloads a month. There are plants at East Pittsburgh, Pa.; Newark, N. J.; Cleveland, O.; Shadyside, Pittsburgh; Bridgeport, Conn.; Bloomfield, N. J.; Milwaukee, Wis.; New York City; Springfield, Mass.; Chicopee Falls, Mass., and Meriden, Conn.

CHAPTER XII

THE GENERAL ELECTRIC COMPANY

A Brief Review of the Organization and Development of the Largest Electrical Enterprise in the World

THE electrical manufacturing industry as we know it today is, though gigantic, of recent origin. Except as applied to the telegraph, such electrical apparatus as existed four decades ago were popularly regarded as little more than scientific toys. Only a few men of technical understanding and scientific vision then had any premonition of a time when electricity would bear any important practical relation to the common life.

The young person of today can scarcely conceive a civilization bereft of the innumerable electrical ministrations and conveniences with which they are so bountifully supplied, so commonplace they seem. But another generation, not yet old, remembering the origin of these things, looks out with ceaseless wonder as upon a world transformed by electrical industry.

The vastness of this industry is best typified by the General Electric Company, the largest electrical enterprise in the world and yet, with activities that employ more than eighty thousand men, still acquiring enlarged business and expanding its operations with each succeeding year.

The General Electric Company was formed in 1892, and in it were combined two groups of companies, previously competitive, which had been engaged in the manufacture of electrical machinery and apparatus. One of these groups was know as the Edison General Electric Company, which had combined the several Edison corporations into one company in 1890, and the other was the Thomson-Houston Electric Co., which had acquired various other interests and brought them into the General Electric Company in 1892.

The bringing together of these various companies was much more than a good stroke of business. Mr. Charles A. Coffin, for years president and now chairman of the board of directors of the General Electric Company, showed exceptional ability as an organizer and financier when he brought together the diverse elements which have since been harmoniously blended in the General Electric Company. Although the volume and importance of the industry in 1892 were not a tithe of what they have since become, the industry had progressed far enough to demonstrate the fact that the development of the electrical manufacturing industry upon a scale proportionate to the demands upon it required control of much greater capital and vastly superior facilities than those which any of the individual companies entering the amalgamation could hope to command. The minor companies had been measurably successful, but were hampered by financial and equipment restrictions from achieving the greater results at which they aimed. A short review of the industry prior to the organization of the General Electric Company will serve to illustrate the factors in its early development.

Thomas Alva Edison, born in 1847, is justly acclaimed as the foremost American inventor, whose genius has been manifested in many of the most important electrical devices, among which his incandescent lamp, which was produced October 21, 1879, has been justly designated as epoch-making. This was the beginning of the great Edison group of industries which afterward became a vital part of the General Electric Company. Edison's Menlo Park laboratory was the earliest manufacturing plant for the production of incandescent lamps. Here also were manufactured generators to supply the current required for the operation of incandescent circuits. The first Edison generator was known as Edison's "Jumbo" generator, and was driven by a steam engine. This machine was the forerunner of a long series of steam-electric generating sets, of constantly increasing size and capacity, until at the present time single steam turbine generating sets have been constructed to give an output of 45,000 kw. The production of generators of the Jumbo No. 1 type was continued for a time at Menlo Park. These generators were arranged for direct engine drive, and were built in a considerable number for central station use. The Edison interests were first incorporated as the Edison Electric Lighting Company, with a capital stock of $300,000. The demand for generators outgrew the facilities for their manufacture at Menlo Park, and in 1881 the machine tools were removed to a factory on Arch street in New York City, where, with increased equipment for manufacture and steady improvement in design of generators, the enlarged demand for these machines was met.

The manufacture of incandescent lamps began at Menlo Park in 1879 with the use of carbonized paper as filament material. Mr. Edison was not satisfied with this material, and a world-wide search for something better resulted in the use of bamboo filaments. After the generator part of the Edison industry was removed to New York, the lamp industry remained at Menlo Park for a time; but the facilities there proving inadequate, a factory for their manufacture was built at Harrison, N. J., forming the nucleus of the great lamp industry located in a group of large and modern buildings there, now known as the Edison Lamp Works. Besides that plant, another of special completeness of equipment and vast production is located at Nela Park, Cleveland, Ohio, known as the National Lamp Works. These two great plants, producing lamps at the rate of more than one hundred million per year, form a very important part of the activities of the General Electric Company, giving employment to more than eight thousand workers, of whom about eighty per cent are women.

Resuming the historical sequence of this industrial history, it is appropriate to refer to the separate organization of the various departments of Edison activities, beginning with the incorporation in 1884 of the Edison Machine Works, with a capital of $200,000, taking over the New York plant and the manufacture of generators; and in the same year the lamp business was separately organized with a capital of $250,000 as the Edison Lamp Works. In 1885 the Edison Electric Tube Company was organized, with a capital of $25,000, and a corporation with a capital of $10,000 was formed for the manufacture of shafting, belts, hangers, etc. Other separate companies were the Edison Company, for Isolated Lighting, and the Sprague Electric Railway and Motor Company, for the production of stationary motors and the apparatus for street railways, developed by Frank J. Sprague. It was in August, 1890, when these several companies were combined into a single organization by the name of the Edison General Electric Company. The manufacture of generators by the Edison Machine Works had been removed in 1886 to Schenectady, N. Y., into two buildings which had been erected about three years before by the McQueen Locomotive Company. The occupation of these buildings by the Edison interests was at first designed only to be temporary, leaving the question of a permanent location for later consideration. But these buildings (still used and forming buildings No. 10 and 11 of the present great plant) were soon overtaxed by the growth of the industry, and other buildings were added to the plant in 1887 and 1888. Through all this transition period and creative up-building of a great industry, the

guiding genius was that of Mr. Samuel Insull.

The other group of industries which entered into the organization of the General Electric Company, known as the Thomson-Houston group, which had its origin in the researches and inventions of Professor Elihu Thomson in connection with the arc lamp and the generator, which were begun at about the same time as Mr. Edison started his investigations, which resulted in the invention of the incandescent lamp. Born in 1853, Professor Thomson had always been interested in chemistry and mechanics, and was holding that chair in the Philadelphia Central High School (a collegiate institution), while he manufactured, in a small machine shop, in Buttonwood street in Philadelphia, an experimental arc machine and some arc lamps. He himself wound the armature and fields for this machine. When it was completed he tested it and found that it would carry eight lamps in series. The result of this work was the organization in the spring of 1880 of the American Electric Company, with a small factory located at New Britain, Conn.

Professor Edwin J. Houston who had, like Professor Thomson, been an instructor in the Philadelphia Central High School, and had been associated with the early experiments in arc lighting, came into the business in 1883, when the American Electric Company was reorganized as the Thomson-Houston Electric Company, and the entire equipment, in the fall of that year, was transferred from New Britain. Conn., to Lynn, Mass. Eight or ten patents which had been issued to Messrs. Thomson and Houston, jointly, formed the basis of the Thomson-Houston enterprise. In 1884 the manufacture of incandescent lamps was begun by that company. In connection with this branch of the industry a device called a distributor was used, through which a constant current of 9.6 amperes was carried and split into ten circuits. The arrangement provided for the insertion of equivalent resistance wherever any of the lamp filaments broke. By 1885 and 1886 this incandescent lamp work went up to 110 volts, and the manufacture of generators for supplying energy at that voltage was begun. The first Thomson dynamo, with spherical armature and cup-shaped fields, had been developed in 1879.

Original Buildings of the Edison Interests (now General Electric Company) at Schenectady, New York, in 1886

In the development of the arc lamp the Thomson-Houston plant at Lynn took a leading part, and in 1885 this industry had greatly developed a new type of lamp, known as the Thomson-Rice lamp, superseding the original lamp, which was known as the "D" lamp. Edwin W. Rice, Jr., had been a pupil of Professor Thomson at Central High School, Philadelphia. He began practice as an electrical engineer in 1880, became superintendent of the Thomson-Houston Electric Company in

1883, and was identified with much of the early experimental work of that company and of the General Electric Company, of which he became chief engineer and finally president, which office he now holds.

Incandescent lamps were made at the Lynn works for several years. It was felt to be a well-grown industry when, in 1887, five glass-blowers were employed in those works to do all the tubing work for incandescent bulbs and, in addition, to attend to the manufacture of the Sprengel pumps, which were employed to exhaust the lamps and create the necessary vacuum. Later the manufacture of lamps at Lynn was discontinued, and the entire lamp industry was concentrated in special groups of factories elsewhere, which were specially equipped for their production.

The modern electric motor is familiar, in its various types, to every one who is connected with or a visitor to industrial plants of almost any kind, and yet the original stationary motor was built at the Lynn works as late as 1886. After various tests were made this motor was redesigned and the new type which resulted from them was reproduced in various sizes for several years. The frames of these machines were used for both motors and generators, although the windings for the two machines were, of course, different. A large number of these motors were made and went into use and their manufacture became an important industry, but the total number of motors made during the years these types were made would amount to only a fraction of the total number of motors now made in a single year. The manufacture of motors is still a very important part of the activities of the Lynn works. This is particularly true of the smaller types of motors. The small motor department of the Lynn works, as it is carried on today, occupies the largest building in the world devoted exclusively to the manufacture of a single type of apparatus. It is a large reinforced concrete structure of the most modern construction, 810 feet long, 80 feet wide, and has three floors with an aggregate area of 218,400 square feet. Forty thousand motors having a total capacity of about 200,000 h. p. were built in one year in this building, the range of size in the motors manufactured there being from one-half to twenty-five h.p. More than one thousand persons are employed in this building.

General View of the Schenectady Works, General Electric Company

With the improvement in the mechanism of lamps, motors and generators the need of measuring instruments by which the amount of current consumed could be accurately determined became apparent, and in 1889 the Thomson Recording Wattmeter was evolved. It was warmly welcomed in the electrical world, but there has

been a remarkable evolution in the science of electrometry since then, with a corresponding development of measuring instruments, which have placed electrical service upon a basis of exactness in methods and results with which no other source of light, heat or power can compare.

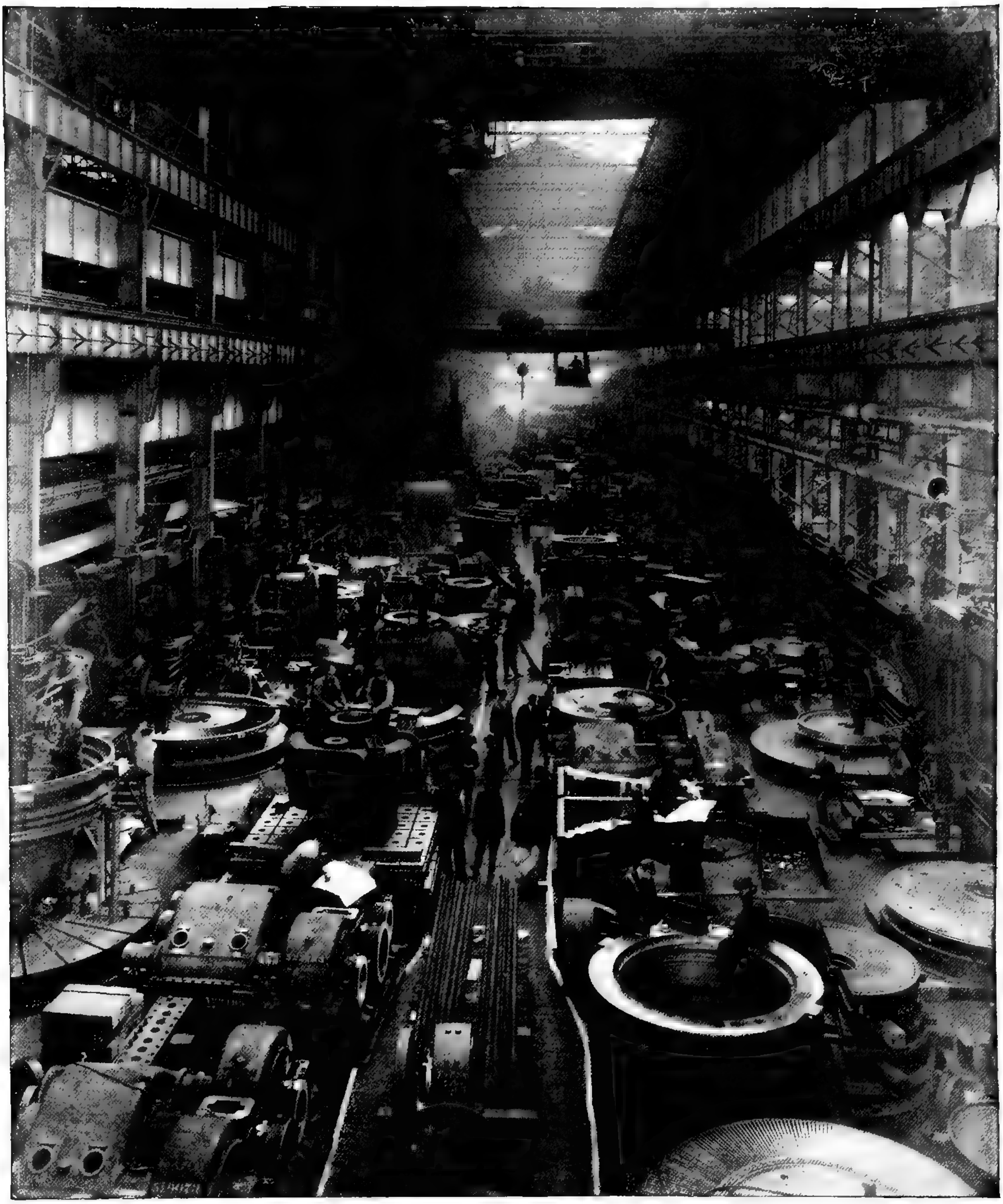
The transformer was an early product of the Lynn works, that first produced and known as "Type A," dating from 1887. Progress in the electrical industry has few more effective illustrations than a comparison between this primitive though useful device and the larger modern illustrations of self-cooled, water-cooled and air-blast transformers. Another device which received early attention in the Lynn plant was the alternating current generator of which an original type, with belt-driven exciter, was wound with "pancake" field coils, oil cups being used to lubricate the bearings. This old type has many points of resemblance to modern units of corresponding size, but the mammoth alternators, which are now installed in large modern power stations, are of widely different construction.

The Thomson-Houston Electric Company was one of the pioneers in the construction of electric railway apparatus. It manufactured a railway motor known as the "F-40" type, as early as 1886. This and other early types of railway motors were equipped with oil cups for lubrication of the bearings, but later types of which the "D-62" railway generator was probably the earliest, had eliminated the oil cups and had self-oiling bearings.

Headquarters Building, General Electric Company, Schenectady, New York

The same company was also a pioneer in the production of electrical apparatus for warship service, a very early installation of that kind being a generator set consisting of two machines, direct-driven by a marine type steam engine, comprising the first four-pole generators built by the Thomson-Houston Company. This equipment was installed on the United States cruiser "Vesuvius."

The Thomson-Houston Electric Company, before it combined with the Edison interests to form the General Electric Company, had acquired several smaller companies, each of which owned important patents (some of them basic), and in-



Schenectady Works of the General Electric Company for the Manufacture of Large Turbines—the Largest of the kind in the World

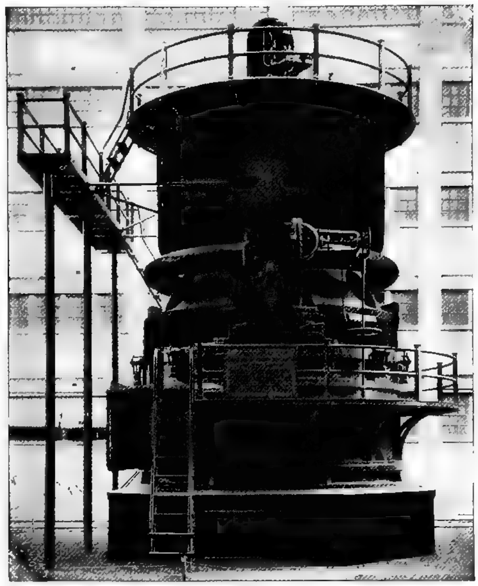
cluded among their employees men of engineering talent and inventive ability. One of these, the Van Depoele Company, which was secured by the Thomson-Houston Company in 1886, owned valuable railway patents, Charles J. Van Depoele, its founder, having been the originator of the trolley system, which has been the means of the greatest revolution in urban and interurban transportation ever conceived.

In the arc-lighting field the foremost competitor of the Thomson-Houston Elec-

tric Company had been the Brush Electric Company, which had at one time threatened to absorb the Thomson-Houston Company, which, however, secured the Brush Company in 1889. In 1890 the Schuyler Electric Company, which manufactured arc lighting apparatus, and the Excelsior Electric Company, which had also been a competitor in the arc lighting field, were acquired by the Thomson-Houston Company, which, by these acquisitions, attained a position of great strength in the arc-lighting industry and gave exceptional value to its contribution to the larger organization formed in 1892, when these great interests and those of the Edison General Electric Company were consolidated into the General Electric Company.

By 1892 the electrical industry had reached a place of great importance and a degree of development, the principal obstacle to which was the competition of the two great companies which controlled the most important inventions. The patent claims of the two companies conflicted; the salesmen of each were trying to beat the other in their respective fields. Wherever an important installation was to be made the competition was fierce. Each held patents for apparatus which would greatly improve the other's product if they could be used. The two companies were working in the same field by divergent methods. The situation was such that the highest efficiency and the greatest progress in the industry, as well as the largest and surest profit to the investors in the two companies could only be secured by their unification. Quite a number of the larger stockholders had holdings in both companies, and among them were men of genius for corporate organization who envisioned the future progress which a combination of the engineering genius and financial backing of the two companies would make possible. The efforts of these forseeing men, under the generalship of Mr. Charles A. Coffin, culminated in the formation in 1892 of the General Electric Company, which acquired the capital stock of the Edison General Electric Company, the Thomson-Houston Electric Company, and the Thomson-Houston International Electric Company. The result of this epoch-making unification has been justly and tersely summarized in the following paragraph in regard to it from an address of a distinguished electrical engineer:

"Never in the industrial world did organization effect a more magical change in releasing pent energy. Guided by master hands, electrical arts leaped into industrial pre-eminence, volume of manufacture of appliances, progress of invention, public confidence in electricity, and its general utilization, all took long strides forward."

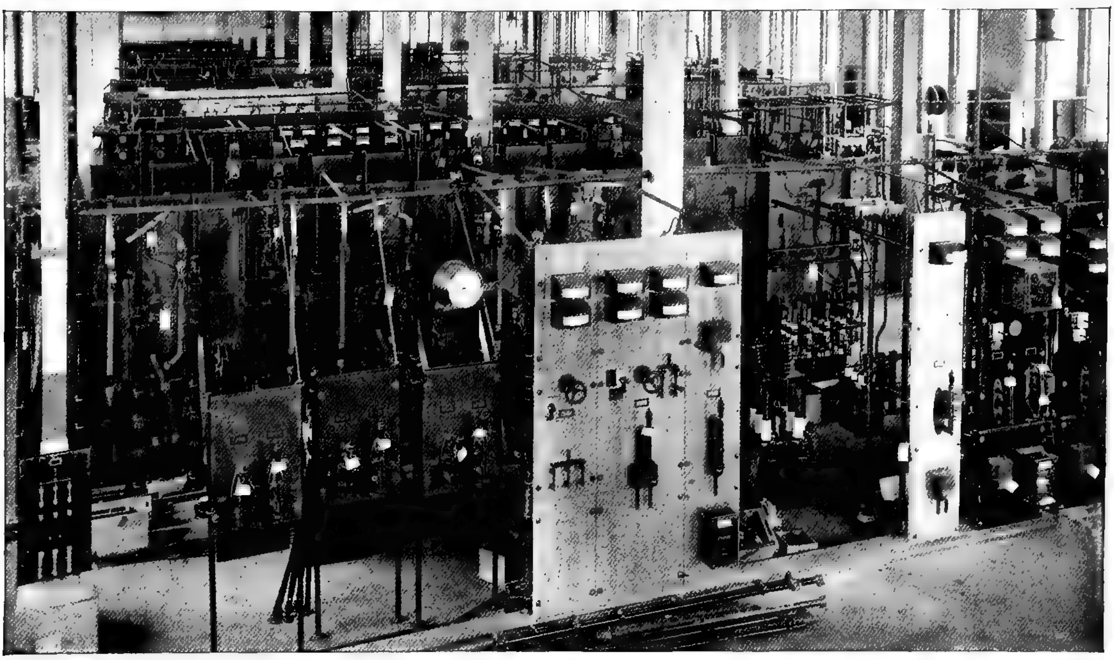


First Commercial Turbine Generator Now Erected at the Schenectady Plant as a Monument to the Industry

Since the creation of the General Electric Company it has acquired other companies and properties in this country and abroad, and has been the main industrial and engineering factor in the evolution which has made the past quarter century known as "the Age of Electricity." In all of the avenues of progress and invention along electrical lines the General Electric Company has been a prime mover, and the impress of its creative energy appears in every country of the world where electrical improvement has found a footing.

The principal factories of the country are now located at Schenectady, N. Y.;

Lynn and Pittsfield, Mass.; Harrison, Watsessing, and Newark, N. J.; Erie, Penn.; Cleveland, Ohio, and Fort Wayne, Ind., in addition to which are various smaller plants, each specializing in a certain class of apparatus. In all the company has in this country a total of more than eighty thousand employees. The expansion of the company's operations has been marvelous and continuous from its organization, but especially in the last decade, the floor space occupied by them having in the past ten years increased from 7,000,000 square feet to an aggregate of 18,000,000 square feet.



One of the Three Switchboard Assembly Floors. Schenectady Works

Greatest among the plants of the company is that at Schenectady, N. Y., the largest in the world devoted to the manufacture of electrical machinery and apparatus. More than twenty thousand people are employed at this plant. No more interesting aggregation of industrial and technical achievement exists on any site in the world than is consolidated on the 332 acres covered by the Schenectady works.

Just inside the main entrance to the plant is the headquarters of the company. It is the largest office building anywhere devoted to the business of a single company, and houses about 2,500 employees of the commercial and engineering departments.

It is difficult to give even a brief summary of the mechanical equipment of this constantly enlarging plant. The figures of last week, to be absolutely correct, need to be revised upward, but a rather recent statement enumerates that the mechanical equipment then comprised more than 10,000 machine tools, more than 200 traveling cranes, more than 8,000 motors, and that electric energy for the plant is supplied by transmission line from a distant water-power station and locally by steam power stations.

The plant includes several machine shops. One of them, of typical completeness, is 850 feet long, has a battery of overhead cranes and a vast number of machines, each of which is individually driven by an electric motor. The testing department is especially thorough, and the section which handles motors has a comprehensive range of effectiveness, dealing with motors of from 5 h.p. up to 2,000 h.p.

Another department produces wiring de-

vices in enormous quantities, including sockets, switches, cut-outs, fuses, panel boards, etc., and most of it being light work, many of the employees in the department are women. In this connection there is also a department for the manufacture of the porcelain parts, for the production of which in the vast quantities needed, huge kilns are used for firing. Another branch is that for the manufacture of wire and cable, of which more than 200,000,000 feet per year is produced.

The manufacture of switchboards constitutes another important department, and on one of the assembly floors the completed switchboards are mounted and tested to the number of about fifteen thousand per annum. This is a branch of the industry calling for diversified materials in large quantities—rubber from Brazil, marble from Vermont, slate from Maine, copper from the Pacific States, etc.

One of the most prominent achievements of the Schenectady plant is the work it has accomplished in connection with the development of the steam turbine for the propulsion of electric generators. Not only is the turbine department remarkable as a manufacturing plant, but in the engineering and experimental work it has done, many of the best improvements in construction and mechanism of steam turbines having been worked out in this plant. The equipment of the large machine shops at Schenectady devoted exclusively to the manufacture of turbines includes some of the largest planers and boring mills in the world. Only the large-size turbines are produced at the Schenectady plant, those rated at from 10 to 2,500 h.p. being produced at the Lynn plant.

The first large Curtis steam turbine generator equipment ever built was turned out at the Schenectady works and installed in the station of the Commonwealth Edison Company in 1903. It was regarded as a marvel, being rated at 5,000 kw., and was, when installed, the largest steam turbine in existence. It remained in active service until 1909, when it was replaced by a later type of turbine generator of much greater capacity, while this first generator equipment was brought back to Schenectady and placed in the main avenue of the works there as a monument. It represents a new departure in turbine design and construction, the first triumph in a branch of electrical development in which the General Electric Company has pioneered and improved until now combined turbine generators made at this plant, with rated output of 30,000 kw. or more, mark the highest advance reached in that class of dynamo-electric machinery.

It would not be possible in the space here at command to give anything like a detailed description by departments of the activities of the Schenectady and other plants. The marine department, where the largest and best equipments for the greatest giants of the new navy, now in the course of construction, are being produced, including new and unprecedented equipment for electric propulsion of these vessels, are in progress, the searchlight department where the latest improved searchlights for land and naval use are being manufactured and constantly improved; the department where electro-therapeutic equipment is turned out, including besides many other things, a greatly improved type of X-ray apparatus, and other and various activities of manufacture appropriate to a plant at once the largest and the most modern, in equipment and products in existence.

The purely technical, as distinguished from the mechanical and manufacturing, activities of the headquarters plant, represent a degree of efficiency certainly not surpassed elsewhere. The drafting department, in which approximately one thousand people are employed producing drawings as they are needed preliminary to the manufacture of the varied lines of manufacture of apparatus, is believed to be the largest drafting department in the world. Its output now exceeds thirty thousand drawings yearly.

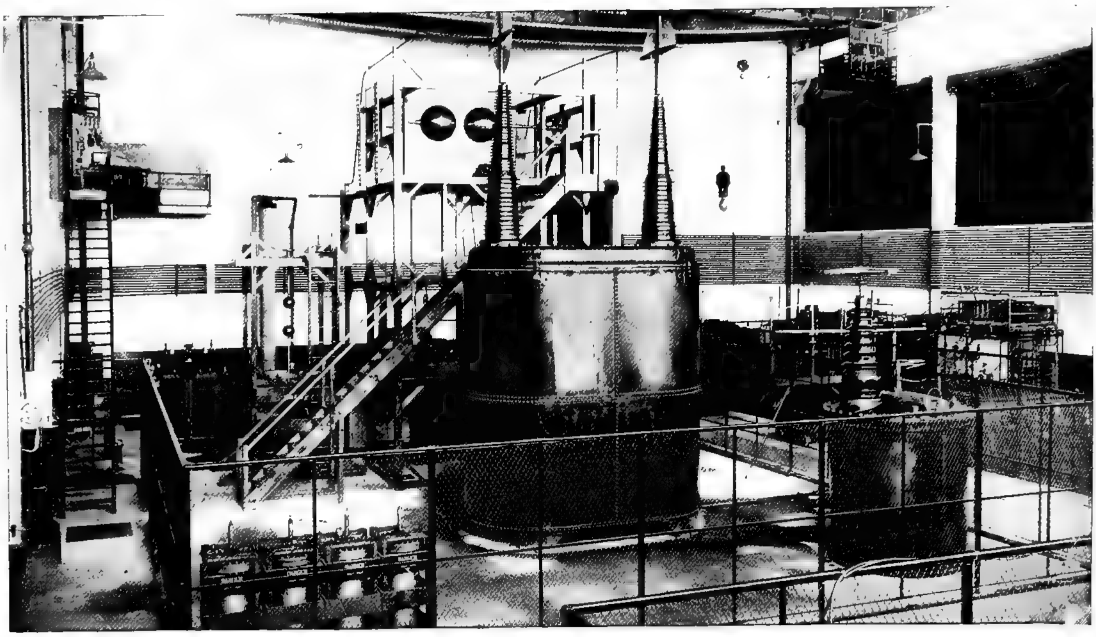
The standardizing, testing and research laboratories are of vital importance to the company's success and progress. The selection of materials to be used in construction is here determined by chemical and mechanical analysis. New methods and processes of manufacture are brought out and perfected, new machinery invented, and constant research made for the purpose of improvement of the existing products of the company.

The research laboratory, under the direction of Dr. W. R. Whitney, is a factor of supreme importance in maintaining the

company's prestige and leadership. Many and valuable are the developments that have come from its fruitful researches. Here the Curtis steam turbine was developed to its present high efficiency; the D'Arsonval instrument was produced; numerous heating and cooking devices for commercial and household use were developed; the mercury arc rectifier was successfully worked out; the General Electric induction motor was invented. Here, too, was carried on the experiment and research which produced the metalized filament and drawn wire Mazda incandescent lamps, work which practically revolutionized modern electric lighting practice; besides many other inventions and devices which have added most materially to the use and value of electricity in its manifold applications.

To refer briefly to the other plants of the company we may first speak of the Lynn works. The original building known as Factory A was built in 1884. The plant has been developed until now it extends over a tract of two hundred acres, with numerous large buildings, having a floor space of about three million square feet, and employing more than twelve thousand workmen. As at Schenectady, the number of departments is large. Speaking in general terms of the production of machinery in the two plants, the larger sizes and high capacity types of generators, turbines and motors are the products of the Schenectady plant, while those of smaller size and lower rating are produced at the Lynn plant.

The arc lamp department is an important one at the Lynn works, where much of the early development of arc lighting had its origin. One of the largest factory buildings in Lynn is put to use as an assembly room for the General Electric modern high efficiency arc lamps.



High Tension Testing Laboratory, Pittsfield, Mass., Containing 750,000 Volt Transformer — Highest Tension Transformer in the World

The Pittsfield plant is also an important one. It has a ground area of about ninety acres, and employs more than five thousand workers in the factory buildings, which have an aggregate floor space of nearly two million square feet.

The manufacture of transformers, which was formerly carried on at both the Lynn and Schenectady plants,is now concentrated at the Pittsfield Works. The assembly department for transformers assembles units

ranging in capacity from 5 to 15,000 kv-a., for operation on transmission lines having potentials up to 150,000. The transformer testing department at that plant is the largest and best equipped in the world, having a capacity for testing each week 2,000 lighting transformers and a total of 59,000 kv-a. in power and lighting transformers. This is approximately equivalent to 10,000 kv-a. per day, or 3,000,000 kv-a. per year. The Pittsfield plant also manufactures feeder voltage regulators, the assembly department for which has a capacity for about 2,500 annually, ranging in size from ½ kv-a. to 800 kv-a. The electric fan motor department at Pittsfield uses over 68,000,000 parts in the production of 150,000 fans annually.

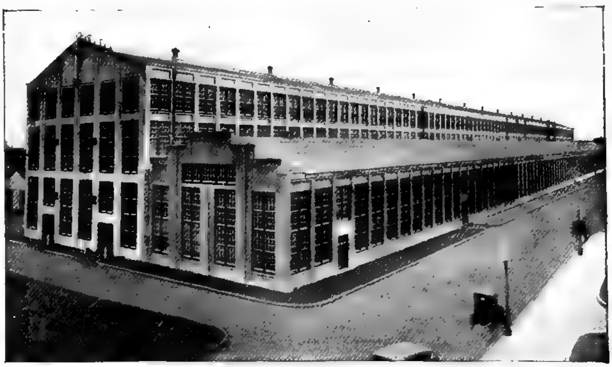
The foundry and pattern storage yards at Pittsfield are large and fully equipped, and the facilities for receiving and shipping of road materials are especially complete and convenient in arrangement. The production of transformers, voltage regulators and other electrical apparatus produced at Pittsfield calls for the use of an enormous quantity of steel, and the punch press department is very appropriately equipped for cutting up over 30,000,000 pounds of steel annually.

The works at Erie cover a ground area of sixty-six acres, and its buildings have a floor space exceeding a million square feet, while its employees number about 3,000.

The iron foundry of this plant is very large and specially designed to handle large quantities of material at a minimum expenditure of time and labor. It embodies the most advanced ideas in foundry equipment, including a complete outfit of electrically operated cranes.

This plant is largely devoted to the production of electric railway and mine haulage locomotives. The locomotives built at this plant include the most improved types of electric locomotives for passenger and freight trains, and in mine locomotives there are numerous forms adapted to the various limitations involved in mine operation in both metal and coal mines.

The great lamp works at Harrison, N. J., and at Nela Park, Cleveland, Ohio, are monuments to a progressive evolution in lighting. It is a far cry from the little building at Menlo Park, N. J., where the first incandescent lamps were made in 1879, to these great plants, each occupying groups of large buildings. The difference in the output is as dozens to millions, and the difference is immeasurable between the first unstable lamps, with their fragile filaments, and the present substantial, brilliant, steady "Mazda" lamps, the filaments of which, although of spider-thread dimensions, are stronger than piano wire, and have revolutionized the art of incandescent lamp manufacture.



A Section of the West Lynn Works

Besides the plants specifically mentioned, there are several others, each devoted to a special part of the industry, so that the company is known in the manufacturing world not only as a large producer of machines, apparatus and supplies for electrical installations and operations of various kinds, but as a great enterprise in which the problems of modern industry have been worked out to satisfactory solution. To the student of social problems the working of so great an enterprise, with more than eighty thousand men and women on the payrolls, is a matter of deep human interest outside of its industrial importance. Mr. E. W. Rice, Jr., president of the company, when asked, "Does welfare work pay," replied, "Yes, we are sure that it pays, although we may not be able to show it on our books, but in any event we shall continue it, because it is a service we owe to our fellowmen and to the ideals of American industry." In pursuit of this policy the company has in continuous operation systematic plans for the selection of

its efficient working force, and the maintenance of its high physical, mental and moral standard.

The surroundings of the Schenectady plant illustrate the transforming effect of electric service on modern industry. The old idea that a great manufacturing plant must of necessity be surrounded by a "slum district" is entirely dissipated. The excellent trolley system which centers in Schenectady, with about 80 per cent of its cars marked "G. E. Loop" give the employees access to all sections of Schenectady and surrounding towns and cities, as well as country districts, where the employees may have the advantage of rural environment. It is largely this favorable home factor which accounts for the general high grade of the employees of the plant. One's home conditions have much to do with his personal character and demeanor.

But the standards of quality of the employees of the General Electric Company are not left to chance selection. New employees for all branches of the organization, offices and works, pass the physical examination, no partiality being shown—even to consulting engineers. These physical examinations frequently result in the discovery and correction of defective eyesight and other ailments. These physical examinations determine not only whether the applicant shall be employed (rejections have varied from 3½ to 6 per cent in different years), but also the character of employment. A man with weak eyesight will not be set to work near rapidly revolving machinery, nor one with weak lungs permitted to work in dusty rooms. Besides the original medical examination, those who do work of a dusty nature are periodically examined. Anyone who has the appearance of lung trouble, or other disease, which may be aggravated by his occupation, is given a special additional examination in order to detect, and therefore to prevent, any tendency toward disease. If such is discovered, necessary precautions to safeguard his health are advised, or the nature of his work is changed. If such a policy had prevailed in industries of the past, how many whose lives were occupationally shortened would have been preserved to live out their normal span?

Besides examinations, the medical departments have the care of the health and physical safety of the employees at the plants. Hospital facilities are provided at all of the numerous works of the company. Every injury occurring at the works or offices is counted as an accident, employees being encouraged to report even an insignificant scratch, for any scratch may become serious from infection. Thus it is that in 1916, with nearly twenty-one thousand employees at the works, day and night, there were 13,190 accidents at the Schenectady works. Out of these only thirty-six were serious enough to be classed as bed cases, and only eleven serious enough to require an ambulance call, and only two were fatal. The fatal accidents in the Schenectady works that year thus represented 0.099 per 1,000, as against 0.73 per thousand as the average of fatalities of occupied males by accidents in the entire country. The average deaths by accidents in the last decade in the Schenectady works were only 0.136 per thousand. Girls and women are under the medical care of a woman physician. Further particulars as to the medical service of the company might be given to much length, but it includes education in "first aid" to the fore-

General View of the Pittsfield, Mass., Works of the General Electric Company

men, assistant foremen and shop clerks of each department, and the supplying to each department of "first aid" chests containing the necessary materials; girls' rest rooms; Red Cross classes; elimination of stools for girl workers, who are now all supplied with chairs with backs; and there is also educational work in personal hygiene and other preventive measures. Nearly all of the welfare work of the company was well under way before the New York State Workmen's Compensation Act was passed by the Legislature. At the other works there is the same care for the medical welfare of the employees, although there are modifications and special features to suit different conditions.

Prevention of accidents is also a noteworthy work in which the company has taken increasingly active interest. Careful protection against accidents by mechanical and electrical safeguards on machinery; education of employees on the subject of accident prevention; safety appliances for ladders; instructions as to clothing proper for prevention of certain injuries; literature on personal hygiene are in use.

There is an employees' organization largely under their own management, with financial transactions totalling close to $200,000 per year, and with 23,000 voluntary members in six different cities and known as the General Electric Mutual Benefit Association. Its protection consists of a death benefit and a weekly indemnity while sick or disabled.

The educational features presented by the company are of exceptional value, not only to the company and its employees, but to the electrical industry and its progress. First of all is the apprentice system, by means of which a boy may obtain a four-year job, and at the end of the term, in addition to having received a good practical education, will have earned approximately $3,000 and become initiated into the wonderful electrical manufacturing industry as a full-fledged journeyman. The General Electric Company has spent on its apprentice department in six factories, east and west, close to $750,000 in buildings, machinery, tools, instruments, class rooms and laboratory equipment. Up to the fall of 1917 there had been 1,598 graduates from the company's apprentice courses, all of whom had become skillful mechanics earning good wages and salaries. The course includes class room instruction, personal attention in training shops to master the rudiments, and after that personal attention in the regular shops, to which they are transferred as they become more advanced.

General View of the Erie, Pa., Works of the General Electric Company

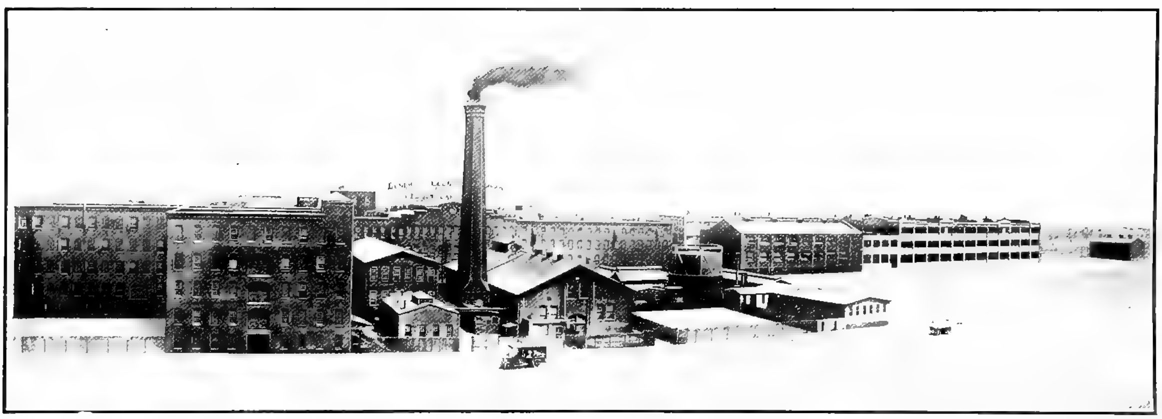
The Electrical Testing Course of the General Electric Company is another of its important educational activities which has become widely famous in the electrical world. It is, in effect, a post-graduate course in electrical engineering. The profession is one in which the scientific theory and technical principles may be well learned in a college course, with such training as the shop-work courses and electrical equipment of the college laboratories provide. But the application of this learning needs to be matured by actual contact with a wide range of electrical machinery, apparatus and installation work before the technical knowledge ripens into practical mastery.

The General Electric Company, with its ever-widening range of electrical invention and manufacture, early introduced a test-

ing course by which the graduate engineer came in contact with the latest developments of electricity in its practical applications, and has developed this into a course to be completed in fifteen months. The course is a direct path between college and business, and at the Schenectady works the average earnings of the test course student during that time are $1,277.15. In the testing department the machines for testing the company's product are operated by the student engineers themselves, and with this operating experience a graduate of the test course can enter almost any main station, substation or switch house and take charge of its electrical operation. Student engineers are continually shifted from one class of work to another and are consulted regarding the sort of work they desire to specialize in and also what class of testing they desire to take month after month. They have opportunities to study and test every kind of engine, machine and apparatus and, if followed to graduation, makes of the student a competent and experienced engineer.

The company gives permanent connection to many of the graduates, and the others, going into professional life in many directions, have found their work in the test course a stepping-stone to success in the profession. It has been a most valuable factor in bringing the electrical engineering profession up to its present high standard of technical and practical scholarship and achievement.

In all its varied aspects—industrial, technical, commercial and educational—the progress of the General Electric Company has, during the past quarter of a century, run parallel with that of the electrical industry itself, of which it is the largest and most influential factor.



General View of the Harrison, N. J., Works of the General Electric Company

CHAPTER XIII

THE STORY OF THE ELECTRIC FURNACE

ALTHOUGH the electric furnace as a commercial device is of comparatively recent origin, its development has been extremely rapid and its size and efficiency have been increased to such an extent that it is now competing with the Bessemer converter, the open hearth steel furnace and the blast furnace in the steel industry, to mention only one of the industrial fields in which its value has been demonstrated. As an example of the progress made in the development of this interesting apparatus, it may be stated that in 1908 there was but one electric steel furnace, with an annual output of fifty-five tons, in the United States. In 1916 there were seventy-three in use and at the beginning of 1917 one hundred and thirty-six were reported as being in service. In almost all the industries the use of heat in some manner is a necessity. Therefore, while heat generated electrically is not in every instance the most economical to use, yet the electric furnace and other forms of electrical industrial heating at much lower temperatures daily are becoming more and more important and valuable.

When we speak of an electric furnace we naturally think of an apparatus in which an extremely high temperature is created and maintained. This is especially true of that type of electric furnace which really had its origin in the discovery of the electric arc by Sir Humphrey Davy in 1800, only a short time after Volta announced his production of the electric battery. Therefore, as the electric arc is the source of heat in an important type of electric furnace, its discovery may be regarded as the beginning of the latter's evolution. Davy also made some of the very earliest experiments in electro-metallurgy, in which the electric current was applied to the production of chemical reaction or molecular changes at very high temperatures. In 1807 he produced the alkali metals by the passage of an electric current through a platinum wire, a platinum dish and a mass of fused caustic alkali. As the intense current passed it melted the mass and the metal was deposited in a liquid state.

The electric arc is produced by the passage of an electric current through two carbon rods in contact at their ends and then moving them apart. The arc itself is a flame of vaporized carbon formed between the two carbon poles. The electric current, when it encounters resistance to its flow, generates heat. As the carbon vapor of the arc offers great resistance to the flow of the current an extremely high temperature is produced, sufficiently high, in fact, to vaporize or melt any known substance. The arc light, therefore, is a miniature electric furnace of the arc type.

Following Davy's experiments, Matthiessen produced potassium by the electrolysis of potassium chloride and calcium

chloride fused over a lamp. In the experiments of these two men we have the genesis of two kinds of electrolytic furnace processes; the first, in which external heat is used to keep the electrolyte in a fused condition and the second, in which currents of sufficient strength develop the requisite heat to cause fusing unaided. A third process, under which calcium carbide is made, uses electricity as a heating agent only. This is an electrothermal process as distinguished from the electrolytic. In making calcium carbide, for instance, the heat generated by the electric current is used to raise a mixture of substances to a temperature at which certain desired chemical reactions will take place. In making graphite from coke or gas carbon, however, the heat is used only to produce molecular or physical changes. The direct current is the only one that may be used in electrolytic furnaces, but either direct or alternating current may be used in electothermal work.

In 1853 primitive forms of electric furnace were produced in France by Pichou and in England by J. H. Johnson. They were strikingly similar in design and in both the charge to be treated in the furnace was reduced to a finely divided state and passed in succession through two or more electric arcs. While this early form of furnace was operative, its efficiency was very low. In like manner, using primary batteries as a source of current, Robert Hare, at Philadelphia in 1839, had obtained phosphorus, calcium carbide, metallic calcium and graphite. Hare, therefore, may be considered to have antedated the work of Sir William Siemens who, in 1878, patented an electric arc furnace whose type was followed by a number of later inventors. Siemens used the dynamo as a source of current.

The furnace usually associated with Siemens' name consisted of a crucible of refractory material, generally graphite, and two rods for leading in the current. The lower rod was of metal and fitted tightly into the bottom of the crucible extending up through it. The upper rod was made of carbon, or was a water-cooled metallic tube, and was connected with an ingenious regulating device for keeping the arc at a constant length. The metal to be fused was placed in the bottom of the crucible in contact with the lower metallic rod. Then the upper rod was lowered until it was in contact with the contents of crucible and an arc was started. A cover, with a hole for observing the progress of the process, was provided to reduce the radiation of heat from the crucible. A furnace with horizontal electrodes was also invented by Siemens.

Faure, in 1883, was granted patents for an electric furnace of the resistance type. The heat was generated by passing an electric current through solid conducting rods embedded into the hearth of the furnace. The same principle since has been applied to the heating units of an electric range. This type of furnace was made a commercial success by two brothers, E. H. and A. H. Cowles, Americans, whose inventions were described before scientific societies in 1885. This furnace was heated by the passage of an electric current through coarsely ground gas carbon or charcoal and was used for various purposes, including the production of aluminum alloys by heating a mixture of alumina and carbon with copper. C. M. Hall, in the United States, and Paul Heroult, in France, were granted patents in 1886 for processes for making aluminum which, as used now, involve the passage of an electric current through fused compounds of aluminum. The electrolytic action of the current frees the aluminum from these compounds, while the heat generated by the current maintains the material in a fused state. This type of furnace consists of an iron box with a carbon lining and provided with a number of carbon rods which are immersed in the fused electrolyte contained in the iron box. The carbon rods form the positive electrode and the iron box the negative. Cryolite forms the principal component of the electrolyte and at intervals alumina, the purified ore of aluminum, is added. The alumina is split up into aluminum and oxygen by the electrolytic action of the current. The aluminum remains in a fused state at the bottom of the box while the oxygen is freed in contact with the carbon rods and consumes them. The loss in carbon is said to be about equal in weight to the aluminum produced. No arc is formed during this

procedure. The electric furnace produces all the aluminum at present used. In 1917 the output in the United States alone was over 100,000,000 pounds.

Henri Moissan, a Frenchman, began in 1892 a series of wonderful experiments with the electric furnace which had for their object the production of artificial diamonds. His work was all on scientific lines and served to establish a basis for the present knowledge of chemistry at the high temperatures of the electric furnace. Moissan's electric furnace consisted of two blocks of limestone and two carbon rods to transmit the current. A hollow cavity was made in each limestone block and the material to be heated was placed in a crucible of carbon or magnesia which was set in one of the blocks. A lining of alternate layers of carbon and magnesia was also arranged around the inside of the cavity to prevent the melting of the limestone and to withstand as well as possible the heat from the arc. Moissan, in many of his experiments, converted two or three hundred electrical horse-power into heat in a furnace with only a few square inches internal dimensions. The enormously high temperatures attained in this type of furnace turn to vapor any material placed in it, except the most refractory, which are reduced to a liquid state. Any metal can be melted and boiled in the Moissan furnace.

He also made many experiments in the reduction of metals from their oxides and checked the statements of C. F. Mabery, in 1885, and Dr. W. Borchers, in 1891, that carbon will reduce any metal from its oxide at electric furnace temperatures. At these high temperatures carbon will also combine with the metal itself and form a carbide. Moissan studied the production and properties of many carbides so formed. His most interesting and marvellous experiments, however, were in the production of artificial diamonds. The diamond is a crystalline form of carbon. If a proper solvent were obtainable it should be possible to crystallize carbon as diamonds. Such a solvent Moissan found in iron and certain other metals. These metals dissolve considerable quantities of carbon under the action of the electric furnace and by cooling them under suitable conditions Moissan obtained a part of the carbon in the form of microscopical diamonds. These he isolated by dissolving away the metal in acids. Although these experiments did not result in the commercial production of artificial diamonds, Moissan's researches on the conversion of carbon into graphite and on the production of calcium carbide were followed by commercial developments of the greatest importance.

Entirely independent of Moissan's work, T. L. Willson, an American, made calcium carbide in the electric furnace in 1892, and later developed its manufacture commercially. Like many other pioneers, Willson had great difficulty in getting together enough money to carry on his experiments, and for a long time before he achieved success used to make frequent calls at the offices of the electrical journals, where he was familiarly known as "Dynamo" Willson. His furnace consisted of an iron crucible with a carbon lining at the base. One side of the dynamo, or transformer, circuit was connected to the crucible and the other to a large carbon electrode suspended within the crucible. After the arc was started between the electrode and the bottom of the crucible, charges of powdered lime and coke were fed in around the electrode. Through the heat of the arc the lime was reduced by means of the coke to metallic calcium and this, secondarily, reacted with more coke to form the calcium carbide which remained in a liquid state below the electrode. By gradually raising the electrode a mass of carbide was built up and when the crucible was almost full the process was stopped until it cooled, when its content was turned out in the form of a block of calcium carbide. Other forms of carbide furnaces have since been devised and are now operating on a large scale. Some of them are of the intermittent type, like Willson's, while others operate continuously. The commercial importance of calcium carbide rests upon the ease with which it acts upon water to form the illuminating gas, acetylene. The annual production is around 300,000 tons at about $80 per ton.

Another carbide, and one of the most important, produced by the electric furnace is one of the carbides of silicon known as carborundum, the hardest abrasive yet found and which will cut the diamond itself. It was discovered by Dr. E. G. Acheson, an American, in 1891, another pioneer who had to struggle his way to final success. After an experiment in which he was attempting to harden clay by impregnating it with carbon in the electric furnace, Dr. Acheson observed a small number of bright particles at the end of the carbon electrode. These particles, when tested, were found to be hard enough to cut glass and even diamonds. This discovery was the foundation of the important carborundum industry of today.

The process of making carborundum consists in placing a mixture of sand and coke with smaller quantities of sawdust and salt in a chamber lined with fire-brick and passing an electric current through a core of carbon placed in the center of the charge. The passing of the current generates a temperature of over 2,000 degrees Centigrade and the sand in the charge is reduced to silicon and combines with the carbon to form carborundum. This material, one of the most valuable abrasives ever discovered, is of a beautiful iridescent crystalline form. It is also employed as a lining for electric and other high temperature furnaces and as a deoxidizer in the manufacture of steel.

The Acheson electric furnace is formed of two permanent end walls which support large bundles of carbon rods held in place by suitable bronze clamps. A mass of broken carbon is laid on the bottom of the furnace between the bundles of rods. This affords a means of passing the current from one bundle of rods to the other and, as the charge is not brought to the fusing point at any stage of the operation, the core of broken carbon remains in place until the end of the process. The carborundum is formed around this core and the material in the unconverted charge which lies above and below it acts as a heat retainer. Between the core and the crystalline carborundum is usually found a layer of graphite which is formed through the decomposition of the carbide in that part of the furnace where the heat is the most intense. As a result of observing this phenomena, Acheson developed a process for the artificial production of graphite which he patented in 1896. This consists in heating coke, or some other form of carbon, in which there is a small amount of iron oxide or certain other substances. At the high temperature of the electric furnace, the iron and other impurities are volatilized, leaving the carbon pure and converted into graphite. The temperature of this furnace often is as high as 2,200 degrees Centigrade and frequently as much as 1,000 horse-power of electrical energy is required to produce it.

As plant life cannot absorb from the air the nitrogen necessary for its existence, the continuous fertility of soils depends largely upon the restoration artificially of the nitrogen removed in the ripe crop. As the supply of nitrates in the world is very limited, recourse must be had to other sources and the unlimited supply of nitrogen in the atmosphere surrounding the earth has attracted the attention of many experimenters. Over a hundred years ago Priestley and Cavendish discovered the combination of nitrogen and oxygen in the electric arc. In 1893 Crookes made an investigation which attracted attention to the possibility of using this reaction for the manufacture of nitric acid and nitrogenous fertilizers from the air. During 1895-6 a number of processes were patented. The Bradley and Lovejoy process already had been tested on a commercial scale at Niagara Falls in 1892. The Birkeland and Eyde process, patented in 1893, is now in extensive operation in Norway and was the first to attain commercial success. Since then other processes have been devised and today the production of nitric acid and nitrates for fertilizers from the atmosphere has assumed almost the proportions of an industry, several hundred thousand horse-power of electrical energy being employed for this purpose. Calcium cyanide is another source of nitrogen for fertilizer purposes. This is produced through the reaction between nitrogen and calcium carbide in the electric furnace. The process was not developed commercially until about 1905, although it had

been discovered about 1895. Over 100,000 tons of calcium cyanide are now produced annually.

Shortly after the firm establishment of the calcium carbide industry, about fifteen years ago, it was found that the production had been developed beyond the demand and it was necessary for the manufacturers to find some other product on which to keep their electric furnaces employed. This was the reason for the efforts then made to find a successful process for the electric smelting of iron, steel and other alloys of iron. The results of experiments made in France, Sweden and elsewhere in 1900 were so satisfactory that the processes developed not only have been able to compete with former methods but, in many cases, the electric process has displaced them. Héroult and Kjellin, in France and Sweden respectively, successfully adapted the electric furnace to making good quality steel from scrap steel and pig-iron. For several years past good crucible steel and special alloy steels have been produced with commercial success from the electric furnace. These pioneers in this field were granted patents about 1900, although a patent for an induction steel furnace had been granted to Colby in 1890.

One of the very earliest inventors in the electric steel industry was Major Stassano, of Turin, Italy, who began making electric furnaces for smelting iron ores in 1896. He was granted patents in 1898 and in the following year demonstrated his process successfully. At this time, however, the prices for electric current were so high that it appeared futile to attempt to compete with the blast furnace using coke, and Stassano's early experiments were received with great doubt of their ever amounting to any degree of commercial success. They served, however, to attract the attention of capitalists and steel men to the electric process and acted as a great stimulant to other inventors.

In 1903 the Canadian Government appointed a commission under Dr. Eugene E. R. Haanel, Director of Mines at Ottawa, to go to Europe and make a report on the electric processes then in operation for smelting iron ores and making steel. The Héroult, Keller and Kjellin furnaces were examined in commercial operation and the production of pig-iron from the ore was also witnessed. On the return of the commission a most comprehensive report was published and Dr. Haanel was able to obtain from the government a further grant with which to carry out in collaboration with Paul Héroult a series of experiments early in 1906 at Sault Ste. Marie in the electric smelting of Canadian iron ores. Following the success of these experiments plants for the commercial production of pig-iron in the electric furnace were built at Héroult-on-the-Pitt, Cal., and at Welland, Ont., Canada. The furnace in California was started on July 4, 1907, but it was not satisfactory in operation and two years were spent in experimental work before Prof. D. A. Lyon developed a successful one. The Welland plant was later utilized for the production of iron alloys. The progressive action of the Canadian Government and the excellent work done by Dr. Haanel and his commission were of great value in the development and growth of the electric process in steel manufacture.

Owing to the abundance of cheap waterpower for the generation of electric current, Sweden and Norway are particularly well adapted to the exploitation of electric smelting processes. In 1907 a number of experiments were undertaken in Sweden by Gröwall, Lindblad and Stalhane. The following year they built their first furnace at Domnarfvet. It had a capacity of 700 horse-power. In 1910 a furnace with a capacity of 2,500 horse-power, which is still in commercial operation, was erected at Trollhättan. Many furnaces of still larger capacity have since been built and industrial processes for the electrothermic production of iron in Sweden and Norway are firmly established.

Since 1902 the production of steel from pig-iron and scrap steel has been a commercial success. It was found, however, that the Héroult type of furnace was better adapted for finishing steel which had been made in an open hearth furnace or a Bessemer converter and then removed in the molten state to the electric furnace. Since 1908 a Héroult furnace of fifteen tons

capacity has been successfully used for this purpose at South Chicago. The Kjellin furnace, which is of the induction type, was found to be well adapted to melting steel but could not be used for refining it. Rodenhauser, in 1907, developed a type of furnace which combined both induction and resistance heating which obviated this trouble and which has been the means of greatly extending the usefulness of the induction type of furnace for steel work.

Some progress has been made in the efforts to produce steel directly from iron ore in the electric furnace, as attempted by Stessano in 1898. J. W. Evans and Dr. Alfred Stansfield, among others, have made numerous experiments which led to results that may prove successful in the future. Only limited success has been had in attempts to smelt zinc ores electrically. Cowles made a number of experiments in 1885 and deLaval patented a furnace for this purpose in 1902. In Sweden a modified form of de Laval furnace is in operation, but the results are reported to be unsatisfactory. W. McA. Johnson, of Hartford, Conn., has devoted many years to investigation of the problem and is understood to have made great progress toward solving it. The electric furnace also has been found satisfactory for certain operations in the metallurgy of copper and of nickel. It is not, however, adapted to the smelting of the arsenical silver ores of cobalt.

As noted in the early part of this account, the development of the commercial uses of the electric furnace has been wonderfully rapid in the past few years. Central electric stations have found that the electric furnace provides an ideal load, because the flexibility of its demand for current can be advantageously utilized to smooth out the load curve for the full twenty-four hour period. The latest reports available indicate that the annual demand from fifty-one steel mills in the United States for current to operate electric furnaces is about 300,000,000 kilowatt hours. At an estimated cost of one cent per kilowatt hour for this kind of service, an annual revenue of $3,000,000 is apparent. There also has grown up a tremendous demand for "electric steel" because it has greater tensile strength, is more homogeneous, has higher elasticity and possesses greater ability to withstand shocks than flame steel. The abnormal situation in the steel industry, largely owing to the world war, also indicates the rapid expansion and growth of the electric process for its manufacture. It is but natural that the steel mills should look to the central stations for their current supply, owing to the great cost of installing isolated electric plants to furnish current for the electric furnace. In modern foundry operation it is considered good practice to melt and pour at night. Thus the consumer may take advantage of the lowest central station rate for current and at the same time provide for the latter a heavy load at the time when it is most needed to balance the load curve. The mutual advantages thus obtainable should go far in the development of the electric steel industry.

One of the principal advantages of the electric furnace is its unusually high efficiency in comparison with the older methods of steel production. The crucible steel furnace fired with coke has a net efficiency of from two to three per cent; the reverberatory furnace for melting metals, ten to fifteen per cent; regenerative open hearth steel furnace, twenty to thirty per cent; the shaft furnace, thirty to fifty per cent; and the large electric furnace, sixty to eighty-five per cent. It also has been demonstrated by careful tests that for one heat equivalent of power supplied to an electric furnace, thirty heat equivalents of fuel would have to be supplied to a crucible steel furnace to melt the same amount of metal. The three principal characteristics which demonstrate the superiority of the electric furnace over other types have been described as follows:

First: The temperature obtainable is limited only by the ability of the refractories to withstand it.

Second: It can be operated in either an oxidizing, neutral or reducing atmosphere or even in a vacuum.

Third: The heat generated not being the product of combustion is transformed from electrical energy at one hundred per cent efficiency.

When it is remembered that the large majority of the products of the electric

furnace are based upon chemical reactions, the advantages of the three characteristics noted above are readily recognized. The yield of products from the electric furnace for a given time is increased because, on account of the great heat developed, reactions take less time and are more thorough. The intense heat secured in the electric furnace makes possible reactions which formerly could not be obtained. This also enables such metals as manganese, chromium, tungsten, titanium and silicon to be smelted.

A most important advantage in the making of steel and its alloys is gained through the use of the electric furnace because its heat can be utilized in any atmosphere or in the presence of various gases. Thus use may be made of their action on other substances or their mutual reaction together. The heat of the electric furnace also is "clean heat"; that is, heat uncontaminated by the products of combustion and obviating, to a great extent, the necessity for using deoxidizing agents in certain processes of steel making. The heat also can be concentrated at the desired point, which results in the fact that the fusing material in the charge of the furnace is at a higher temperature than the crucible itself with a consequent smaller loss in conduction and radiation.

Referring to the use of the modern electric furnace in steel making, a recent issue of *The Electric Journal* says:

"There are two periods in the making of steel. The first is the melting down period of the charge at which time heat can be applied in large amount because the scrap has large capacity for absorbing heat and the furnace refractories will not suffer. The second period is that of real steel-making when purification and deoxidization takes place, the molten bath being refined according to the quality of product desired. It is during this latter period that the chemical reactions take place and the advantages of the electric furnace become most apparent. At this point it is essential that no element foreign to the reactions shall enter and that both the degree of temperature and the length of time it is applied be under positive control.

"To meet the requirement of the first period an immense amount of heat can be applied by burying the arc in the charge, while during the second period, owing to the fact that the heat is not the product of combustion and contains no elements which might be harmful to the reactions, also that it is under almost perfect control as to both time and temperature, demonstrates that the requirements of the two periods of steel-making are better and more thoroughly fulfilled by heat electrically generated than by any method of combustion.

"It must be recognized, however, that the furnace is merely a tool which must be properly used in order to secure the desired product. The mere fact that steel is made in an electric furnace does not mean that it will possess the superior qualities which are already synonymous with 'electric steel.' Like all pieces of apparatus it must be skilfully handled to obtain the best results.

"All steel is an alloy of iron and carbon and contains besides these elements those of oxygen, sulphur, phosphorus, manganese and silicon, in more or less quantities, depending on the quality of the scrap used in the charge. When the charge melts the silicon and manganese combine with the oxygen, sulphur and phosphorus forming compounds and these in turn form a slag. This slag may be either too thin or too thick so that it is necessary to add fluxes to bring it up to the proper consistency.

"Of these elements sulphur and oxygen are injurious and always removed. This is accomplished as well as removal of phosphorus and further separating of the impurities, as is done in smelting and refining, by the basic process, the different quality of the steel depending upon the extent of the refining and alloys used."

The superiority of steel produced electrically over that made under the old flame process has been demonstrated by competent authorities. The advantages of electric steel are briefed as follows by Wm. G. Kranz:

1. Absence of segregation, elimination of oxides, and absolute uniformity of composition, regardless of atmospheric conditions which affect open hearth furnaces.

2. Almost entire elimination of sulphur is possible (an important consideration in steel castings) and complete control of the other elements.

3. Great tenacity, giving ability to withstand much more abuse and fatigue without rupture.

4. High ratio of elastic limit to ultimate strength.

5. A more ready response to heat treatment and with much more uniform results.

6. Perfect control of pouring temperature combined with ability to obtain very hot metal, so that light and intricate shapes are readily cast.

Wm. R. Walker sums up his opinion of the superiority of the electric process for steel making as follows:

1. The more complete removal of oxygen.

2. The absence of oxides caused by the additions, such as silicon, manganese, etc.

3. The production of electric steel ingots of eight tons in weight or smaller that are practically free from segregation.

4. Reduction of sulphur to .005 per cent, if desired.

5. Reduction of phosphorus to .005 per cent, as in the basic open-hearth process, but with the complete removal of oxygen.

The electric furnace already is employed in the refining of gold and at the Philadelphia Mint a Rennerfelt furnace has been installed for the melting of nickel and copper used for coinage. In addition to their four existing plants, the Aluminum Company is completing a new plant at Badin, N. C., which will have an ultimate minimum capacity of 100,000 horse-power. The Yadkin River will afford a supply of electric energy. In the brass industry there seems to be a constantly increasing demand for the electric furnace. Under a patent granted to James R. Wyatt, in 1916, a furnace has been designed which will melt nine pounds of yellow brass per kilowatt-hour of electrical energy. The linings of the furnace, which are reported to cost $25 to install, are said be good for melting 100,000 pounds before replacement is necessary. This furnace is of the induction type and is designed for twenty-four hour service. It has been developed up to a 30 kilowatt size, but larger sizes are in process of manufacture. Other furnaces, of the Snyder, Rennerfelt and Foley types, are in daily use in making railroad brass castings and brass and copper alloys. Another furnace, not of the inductive type, has been in successful trial operation for several months. Preliminary reports state that it requires 250 to 300 kilowatt-hours per ton and that it produces brass having a tensile strength six or seven per cent greater than that of the metal made in the old way. One of the principal advantages claimed for "electric brass" is that the shrinkage loss is greatly reduced.

The proposal recently made that governmental authority should be invoked to create a great "national scrap pile" for the conservation of what heretofore has been waste material would afford a wonderful opportunity for the electric furnace. It is the opinion of those best informed on the subject of electric furnace work that its greatest development may be expected in the transformation into high quality steel of the tremendous and ever-growing scrap piles of the nation.

In addition to the fact that the electric furnace supplies the only known means for the commercial production of aluminum, calcium carbide, carborundum and artificial graphite, its importance in the all-important steel industry cannot be overestimated. For the latter purpose its advantages have been summarized as follows:

1. The utilization of higher temperatures than heretofore have been possible.

2. The utilization of any atmosphere, oxidizing, neutral, reducing or even a vacuum.

3. Reactions are quicker and more complete due to the high temperature, making it possible to use lower grade scrap.

4. Reactions heretofore impossible can now be obtained due to the higher temperature.

5. Quicker heats and more of them, resulting in a greater production for a given time.

6. Saving in space required with the consequent saving in building, overhead, real estate and taxes.

7. Greater thermal efficiency, the generation of heat being at 100 per cent efficiency.

8. More positive and accurate control both of time and temperature.

9. The utilization of "clean heat" and

its concentration upon the material to be fused.

10. Greater flexibility of operation.

11. The production of better steel.

Of fully as great economic importance as the processes made possible by the electric furnace are the industrial uses of electric heating in various manufacturing lines. While it is not true that all of these can be performed by electric heat cheaper and better than by the heat of combustion, yet the wide variety of applications and the tremendous field open to it create for electric heating wonderful opportunities which are increasing in number every day. In response to this demand a considerable number of electric heaters have been designed and manufactured to meet the specific requirements of certain industries. In a general way these may be classified as air or space heaters in which the heating takes place by radiation from metal resistors and by convection; metal heaters in which the material being treated acts as the resistor and the heating takes place by conduction; embedded resistance heaters in which the heating takes place by convection, conduction and radiation; and carbon resistance type furnaces in which the metal resistors are replaced by carbon after the required temperature passes 1,800 degrees Fahrenheit.

One manufacturer of air or space heaters has standardized over sixty different ratings from 1.3 kilowatts to 12.3 kilowatts and from 110 volts to 480 volts. Any number of different combinations can be formed from this line of standard units which can be arranged to provide heat in any required quantity and at temperatures ranging from a few degrees up to 1,250 degrees Fahrenheit. By means of this standardization, therefore, a large number of industries may be supplied with electric heaters which readily can be adapted to the peculiar demands or individual manufacturing requirements of a large number of customers.

The metal heaters are really a process of heating rather than a heating device. The heating effect produced by a large volume of current at a very low voltage passing through the material itself is obtained by localizing the current within a comparatively small definite area. This is the principle of the electric welder and the process is used in arc, butt, spot and lap welding, brazing and upsetting. Electric welding apparatus is made by a number of manufacturers and is so designed as to not only convey the large volume of current required, but also to apply the pressure necessary to complete the weld. In arc welding processes carbon or metal electrodes with suitable holders are a necessary part of the apparatus.

The embedded resistance heaters comprise the greatest number of electric heaters in use at the present time. They are easily applied to a wide variety of uses and are made in many sizes, shapes and heating characteristics. The heating element, which takes the form of a metallic wire, ribbon or grid, is embedded in enamel or is thoroughly insulated with mica or micanite and covered with a metal casing. Asbestos, magnesia, magnesite, soapstone and porcelain also are used as insulating materials. The units of this type are temporarily clamped or permanently fused to the surface to be heated or are immersed in the solid or liquid under treatment. This is the type of heating unit so widely used nowadays in electric cooking devices and electric ranges. They also have a considerable application in air or space heating, as they easily can be inserted and removed from a confined space in which it is desired to generate heat.

The carbon resistance type furnace already has been described in the early part of this chapter. For purposes of economy in current cost, these furnaces usually are designed for a low demand and long hour use in view of the fact that electrical energy is sold on the maximum demand as well as energy consumption basis.

No scale is formed when the electrical process is used for the heat treatment of steel, nor is the metal overtreated so as to be a loss. Devices of great ingenuity have been developed for the control of the heat which can be regulated to a nicety. The use of electric heat in the annealing furnace increases greatly the percentage of metal recovered. Apparatus for heating liquids, melting metal and general hot-plate work is provided with electric heating units of such form and heat generating qualities as to work at the highest efficiency and produce results in the minimum time. By the proper control of temperature,

drying and baking processes can be regulated to the fraction of a degree and the conversion of moisture into steam can be avoided by drying at less than 212 degrees Fahrenheit. In rivetting and upsetting low voltage current is passed through a couple of inches of the blank, raising the temperature so that the head may be formed while the remainder is cool enough to be held in the hand. In electric welding heat of the desired temperature can be concentrated at the exact point required and for any time necessary and no longer. A recent writer on electric heating has summed up its advantages as follows:

Saves time, labor and space with proportionate savings in overhead charges, real estate and taxes.

Can be utilized in any atmosphere, resulting in greatly improved conditions of labor.

Its cleanliness, safety and sanitary attributes cause a reduction in the fire hazard and the chance of loss of material, product and perhaps life itself.

Electric heat is produced without loss and is utilized at from three and one-half to four times the efficiency of fuel combustion devices.

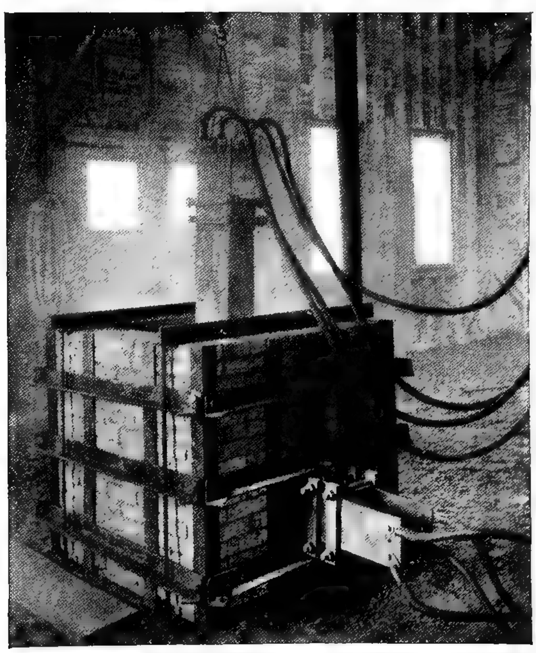
Electric heat can be automatically controlled to a degree impossible with any other method of generating heat.

The requirements of the industrial heating field can be met absolutely as to temperature and quantity.

Electric heat can be concentrated at any desired point and confined to a definite area.

It possesses flexibility to the highest degree and can be applied to a wider variety of uses than can any other form of heat.

When electric heat is used a greater product may be obtained in a given time and its quality will be higher.



CHAPTER XIV

THE STORY OF THE X RAY

IN December, 1895, William Conrad Röntgen, professor of physics at the Royal University of Würzburg, Germany, published a communication in which he announced that he had discovered a new kind of radiation which he modestly called "X-rays" but which since generally have been called Röntgen rays. He followed this with a second communication, under date of March 9, 1895, in which he gave further details of his observations on the new form of radiation, and a third communication, dated March 10, 1897, chronicled his experiments up to that time with the rays and the apparatus for their production.

The discoverer of the form of radiation which afterward was to prove of such great value in medical diagnosis, was born on March 27, 1845, in Lennep, Rhine Province, Germany. He received his doctor's degree at Zürich in 1868 and then became an assistant to Professor Kundt, at Würzburg. After several years he was appointed professor of physics at Giessen and later was transferred to a similar position at Würzburg. Here he engaged in much important research work, most of which bore upon the connection between electricity and ordinary matter. Since his latest communication on the X ray in 1897 little popular mention has been made of his work on this side of the ocean.

The peculiar properties of the X rays have been the subject of much speculation and many hypotheses have been advanced by scientific men who have studied them. In his earliest paper Röntgen inclined to the belief that they were waves due to the longitudinal vibrations in the ether. Afterwards he stated his conviction that they were to all intents and purposes identical with light waves — the transverse waves in the ether. Sir George Gabriel Stokes and Professor J. J. Thomson, in England, and Professor Lehmann, at Karlsruhe, Germany, almost simultaneously advanced the idea that the rays were due to pulses in the ether. This theory, in brief, is that the cathode rays are negatively charged and travel with very high velocity, thus causing disturbances in the ether when their motion is stopped by impact with a solid obstacle. The present theory is that the X ray differs from ordinary light in its wave length.

It is probable that the first X rays were produced by Professor Crookes, in England, in 1875, during his famous experiments with electrical discharges through vacuum tubes. He did not, however, detect the X ray as such, and it remained undiscovered for twenty years. Herbert C. Jackson, in England, and Professor Lenard, in France, came very close to the great discovery in 1893 and 1894. Experiments with electrical discharges in rarefied air and gases were undertaken in the early part of the nineteenth century, and in 1858 Geissler, in Germany, made his first vacuum tubes. The electrical discharge through these tubes, which were of comparatively low vacuum, produced a

soft glow, often striated and greatly varying in form and color with the degree of exhaustion and the gas contained in the tube. About 1860, Professor Hittorf found that the luminous discharge in a Geissler tube could be deflected by a magnet. This discovery bore important results in the later experiments of Crookes, Hertz, Lenard and Röntgen. Several years after the experiments of Geissler and Hittorf, Crookes discovered new phenomena while working with tubes of considerably higher vacuum. He found that when the vacuum in the tube was sufficiently high the luminous glow within the tube disappeared. He also showed that there was a radiation from the cathode which was a projection of particles of highly attenuated gas at exceedingly high velocity. He gave this radiation the name "cathode rays." Because of the peculiar behavior of gas in this highly rarefied state, he conceived it to be as different from gas in its properties as ordinary gas or air differs from a liquid.

His observations on this highly attenuated condition led Crookes to speak of it as the "fourth or radiant state of matter." He also discovered that metallic plates within the vacuum tube intercepted the cathode rays and that the impact of the rays against the glass walls of the tube produced within it a greenish phosphorescence and fluorescence accompanied by an increase in temperature. By concentrating the rays at the focus of a concave cathode he was able to produce brilliant fluorescence and an extremely high temperature at the walls of the tube and in various substances within it. He also noted that cathode rays were deflected by a magnet.

Hertz announced in 1892 that cathode rays would penetrate gold leaf and other thin sheets of metal when placed within the tube. At his death, which occurred shortly after this announcement, his work was carried on by his assistant, Lenard, who discovered that many of cathode ray phonomena could be observed outside of the Crookes tube. He conducted a series of experiments with a vacuum tube closed at the end opposite the cathode with a thin sheet of aluminum and noted that the radiation which proceeded through or from this aluminum wall of the tube would pass through many substances opaque to ordinary light. After passing through such substances this radiation would excite fluorescence in the crystals of many salts and would affect photographic plates in very much the same manner as does ordinary light. It was Lenard's opinion that these phenomena were caused by the cathode rays alone. There can be little doubt that not only Lenard but Crookes, Hertz and other experimenters produced X rays, but they did not recognize them, and it remained for another to bring into practical application the results of many years of patient scientific research.

In the early days of November, 1895, William Conrad Röntgen, professor of physics at the Royal University of Würzburg, happened to notice that a piece of paper coated with barium platino-cyanid fluoresced brilliantly while in the vicinity of a Crookes tube, although the tube was covered with a piece of pasteboard which intercepted all ordinary light. The barium platino-cyanid was at hand because similar materials had been used by Röntgen *inside* vacuum tubes to show the fluorescent action of the cathode rays. Subsequent investigation and experiment showed that the fluorescence was caused by radiations which emanated from the point of impact of the cathode ray against the glass wall of the vacuum tube. This radiation evidently did not produce the sensation of light. Also it was apparent that it passed through cardboard which is opaque to ordinary light. At the same time Röntgen observed that all substances were transparent to this radiation in widely varying degrees depending upon the density of the material. He found that the propagation of the radiation was in straight lines, that it could not be reflected or refracted to any appreciable extent and that it was not deflected by a magnet. More recent experiments have enabled the X rays to be separated into a spectrum somewhat as Rowland, at Johns Hopkins University, separated ordinary light by diffraction gratings. This is accomplished, in the case of the X rays, by using the crystals of rock salt, or other similar materials, in which

the regular placing of the molecules acts virtually as a diffraction grating. It was plain to Röntgen, therefore, that the radiation he had noted was not the same as the cathode rays of Crookes, Hertz and Lenard. Using both the fluorescent screen and photographic plates Röntgen continued his experiments. At this time his work was mostly of a purely scientific character. He was endeavoring to determine, if possible, the exact nature of the new radiation which he called X rays, doubtless because of the use of the letter X in mathematics to denote an unknown quantity.

With photographic plates wrapped in black paper to protect them from ordinary light, he secured with the X rays shadow pictures of metallic objects in a wooden box and of the bones in the human hand. He noted the great possibilities of the X rays in surgery. In December, 1895, he communicated his discovery to the Physico-Medical Society of Würzburg, as already mentioned at the beginning of this chapter. The substance of this communication was telegraphed to all parts of the civilized world and hundreds of investigators repeated Röntgen's experiments and the work of practical development of his discovery was under way immediately. At once the use of the X rays in the diagnosis of fractures and the location of foreign substances in the human body became general. Among the very earliest experiments were those made to determine the effect of the X rays upon pathogenic micro-organisms in culture tubes. No positive results were obtained from these experiments, but shortly afterward a number of investigators observed valuable therapeutic effects when the rays were directed upon living tissues affected with tubercular or malignant disease.

We do not know exactly what the X ray is, nor do we know just what gravitation and many other physical phenomena are; but for the purposes of the physician and the surgeon it is a wonderful thing to be able to produce and control the X rays so that they may do their very important work.

As a summing up of what we do know about the X ray it may be stated that they have their origin within a vacuum tube at the point of impact of the cathode stream against a solid body; that they travel in straight lines; that they cannot be refracted or reflected to the same extent as ordinary light because of their short wave length and the lack of proper material from which to form a prism or reflector for waves of such length; that, because of this, we can obtain only shadow pictures by their use; that their range in quality is much longer than the range of the whole visible spectrum; and, finally, that their successful use depends upon the skill in those manipulations which secure for us the quality and intensity of the ray required to accomplish the desired results. It is rather an important fact that when X rays are intercepted new rays are set up at this point. These were called by Röntgen secondary rays. Some of them are scattered rays, such as are produced in a smoke cloud by a beam of light, while others are "characteristic," that is, their wave length is determined by the chemical elements in which they originate.

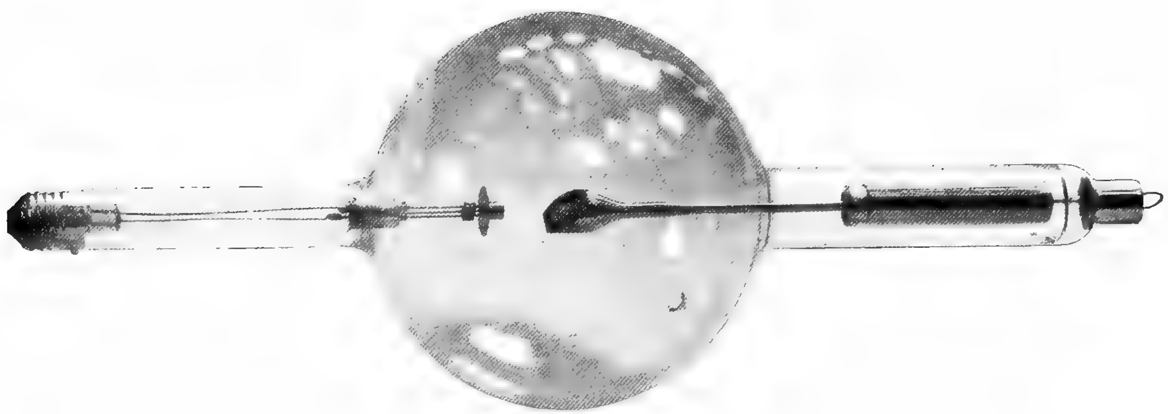
The pear-shaped Crookes tube, in which the source of the X ray is spread over a comparatively large area, was used by Röntgen in his first experiments. Herbert Jackson later made a suggestion which has proved to be what is probably the most useful single addition to the practical side of X ray work, namely, that Crookes' focus tube be used in order to reduce the source of the X rays to a comparatively small area, thus making it possible to produce sharp shadows.

There are two necessary essentials requisite for the production of X rays. One is the vacuum tube and the other is apparatus capable of delivering electrical energy at a potential sufficiently high to produce discharges through the tube. Besides these, a great number of auxiliary devices are necessary, such as tube-holders, switchboards, controllers for coils and static machines, plate-holders, fluoroscopes, operating tables and localizers.

The vacuum tube is a sealed glass bulb, containing two or three electrodes and exhausted to a very high vacuum. One of the electrodes is usually made of alumi-

num, like a concave mirror in shape, and is called the cathode because it is connected with the negative terminal of the exciting apparatus. An electrode formed of a flat disk of metal, connected with the terminal wire extending through the glass bulb, is placed near the focus of this negative reflector. This electrode is commonly connected with the positive wire from the exciting apparatus and sometimes is called the anode. Its essential function is that it receives the impact of the cathode stream and becomes the source of the X rays. Platinum formerly was employed as the material for this electrode, but its use is now almost obsolete. The latest tubes use tungsten embedded in copper or pure tungsten. Tantalum and other metals also have been used. Targets are now usually "chunks" of metal, in order to give thermal capacity and radiating surface. For exciting X ray tubes in practice an electrical discharge at a potential of 20,000 to 100,000 volts or more is required.

The layman should get a clear understanding of the fact that so-called X ray photographs are not photographs at all, but shadow records of objects of varying opacity to the rays. The limitations resulting from this in the use of X days for diagnosis are that diseases which no not produce change in the X ray opacity of the tissues or in the outlines of hollow organs are not well shown. Photographs made by the action of ordinary light on a sensitized photographic plate present to the eye something which is like that seen when looking at the original object. The so-called X ray photographs are an entirely new sort of projection. They are easily mistaken for images, which they are not. For this reason it is difficult to avoid error in the interpretation of X ray plates. They do not, in any respect, correspond with ordinary pictures or photographs. Those who expect to examine X ray plates as they would pictures are certain to interpret them incorrectly. In order to get a safe diagnosis interpretation it frequently is necessary to make a large number of these shadow plates with the X ray at different angles. Correct interpretation of the resulting plates is a highly specialized art. There are many cases in which the X ray alone can be relied upon for diagnosis. There are even many cases in which the X ray furnishes the only certain means of diagnosis, but it is prudent always to consider it as one of many methods of obtaining information. The results of X ray examinations should always be used in connection with other information that can be obtained. The X ray seldom replaces other means of diagnosis, and these other means should not be neglected or overlooked. The X ray really gives us a new method of obtaining information and should be considered an addition to other means rather than a substitute for them.



Standard Coolidge X-Ray Tube

The use of X rays in medical diagnosis is made possible by the fact that different parts of the body obstruct the rays to a

greater or less extent, according to the chemical composition of the parts. The bones, for example, which contain calcium having a rather high atomic weight as compared to the atomic weight of carbon, hydrogen, nitrogen and oxygen which form practically all of the soft tissues, cast a stronger shadow than the latter. Metallic objects, such as bullets, coins, needles and pins, which find their way into the human body, readily are shown on the X ray plate for the same reason. Glass, which is transparent to ordinary light, may be very opaque to the X ray, especially if it is lead glass. Deposits of calcium in the lungs, kidneys, bladder and gall bladder also cast shadows which easily may be recognized by an X ray expert. Detection of pus in the air cells in the bones of the face and skull is made possible by the fact that liquids are much more opaque to the X rays than air and when the air is replaced by a liquid, or pus, a denser shadow is produced on the X ray plate. The normal, healthy lung contains a large amount of air and a relatively small amount of tissue. In consequence of this, slight changes, which in other parts of the body could not be shown, are here detected because of the air being replaced with a material which is denser than air, but which may not be denser than the ordinary soft tissues. Consolidation of the lungs from pneumonia or tuberculosis, as well as fluid in the pleural sac, can be shown for this reason. Fluroscopic examination of the lungs shows the movement of the diaphragm and also the change in density of the lung shadows with inspiration and expiration and thus discovers portions of the lung which are not functioning properly.

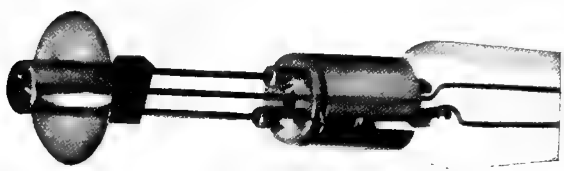
About ninety per cent of the casualties in war are either injuries to bones or the result of bullets or other foreign bodies entering the human body. The X ray played a very important part in the recent world war in the diagnosis of the wounded. It is used, of course, for other conditions that develop among soldiers just as among civilians. It has been proposed to make X ray examinations of the lungs of recruits entering the army in order to eliminate the presence of foci of tuberculosis which may have escaped detection by the ordinary physical examination. In a series of test cases a small percentage (from three to eight per cent) were cases which had passed the ordinary physical examination and were shown to have suspicious lesions in the lungs on X ray examination.

Changes in the size and position of the heart are readily disclosed by the fluoroscope or by X ray plates because the heart is surrounded by the lung, which is relatively transparent to the X ray.

Certain diseases are accompanied by a deposit of calcium in the arteries which frequently can be shown by X ray plates. Hollow organs like the esophagus, stomach and intestines do not cast enough of an X ray shadow by themselves to assist in a diagnosis, but these organs can be filled with an opaque material which makes their outlines clear and enables them to be studied with the X ray, either on the photographic plate or by means of the fluorescent screen. It is possible, for example, to show an obstruction in the esophagus by watching the swallowing of a glass of milk mixed with bismuth carbonate or barium sulphate. The stomach shadow frequently will show filling defects due to cancer or ulcer of the stomach. The emptying time of the stomach, which has an important bearing on the question of disease, can be determined with accuracy by X ray observations after an opaque meal. By palpation with the fluorescent screen the relation of a tender spot to any portion of the stomach or intestine can be discovered. The emptying time of the intestinal tract can be determined and, by palpation under the fluorescent screen, the mobility or fixation of different portions of the tract can be shown. Certain disturbances of the digestive tract may be due to adhesions, or to kinks, which interfere with the free passage through of the opaque meal. These may be located by the X ray. The kidneys are sometimes injected with an opaque solution, such as collargol or thorium nitrate, which causes the outline of the hollow portions to show clearly. The kidneys are very well supplied with blood and usually are embedded in fat which has a comparatively poor blood supply. For the reason that

fat is less opaque to the X ray than the blood, the outlines of these soft organs are usually clearly shown. Changes in their size or position may, therefore, be detected.

The use of the X ray in dentistry has come to occupy a very important position. Infections about the roots of teeth are often unsuspected and in some cases their presence can not be determined in any other way than by the use of X rays. These infections, because they are undrained and the products are absorbed into the system, frequently give rise to profound changes in other parts of the body, notably in the joints. Abscesses about the roots of the teeth readily are shown by the X ray because they produce an absorption of calcium salts in the sur-



Cathode of the Standard Coolidge X-Ray Tube

rounding bone. Imperfect root fillings, pieces of dental drills which are broken off and left in a tooth, unerupted teeth which may cause a great deal of trouble, especially when impacted, are also detected by the X ray.

In the X ray itself there is no appreciable heat. The so-called X ray burn is not really a burn but a more or less profound disturbance of the life function of the cells which make up the tissues which have been unduly exposed to the X rays. This disturbance may even amount to the death of the tissue cells causing slough. This condition, to produce which a very long or intense exposure is necessary, usually is not apparent for from five to fifteen days after the exposure which caused it. In ordinary diagnosis, the dangers from this source have been practically eliminated. The examinations by X ray for diagnosis are ordinarily so far within the limits of safety that the danger is not considered important. The so-called X ray burn is now exceedingly rare, although thousands of examinations are made daily. It is now over twenty years since the first X ray examinations were made and it is safe to conclude that no harm of any kind, either immediate or remote, can result from ordinary X ray exposure.

The effect of over exposure resembles in some respects the effect of sunlight, but is of course deeper on account of the greater penetration of the X ray.

The field for X ray diagnosis has been constantly and steadily increasing. No one can foretell what its limits may be in the future. At present it has sharp limitations which are not always thoroughly understood. Therefore, the X ray in medical diagnosis should, when possible, be handled by a physician who has made a specialty of the subject. Very serious results have occurred from the incompetent use of the X rays, both in the matter of burns and the incorrect interpretation of the plates. X ray apparatus should not be used by physicians who have neither the time nor the opportunity to acquire skill in its employment.

The question of the therapeutic value of the X rays in the treatment of certain diseases is still a subject of discussion. It is but natural to assume that an agent of which we know as little as we do of the X ray should be used with the utmost discretion and only by those who have studied its effects most thoroughly.

The X ray is gradually finding a place for itself in the industrial field. At least one manufacturing company maintains a research laboratory in which the X ray is used to detect metallic particles in mica. Tobacco has been subjected to the X rays for the purpose of killing the eggs of the tobacco worm which destroys many thousands of dollars worth of manufactured tobacco every year. The treatment is reported to have been successful. In pearl fisheries the only way in the past to tell whether a mussel contained a pearl was to open the shell and look. This, naturally, destroyed the mussel and caused it to be a total loss as far as being a possible producer of pearls in the future. Certain fisheries have installed X ray apparatus and now examine each mussel with it. If the mussel contains no pearl it is returned to the water, thus eliminating a source of considerable loss and waste.

A genuine diamond is fairly transparent to the X ray, while an imitation stone always casts a shadow.

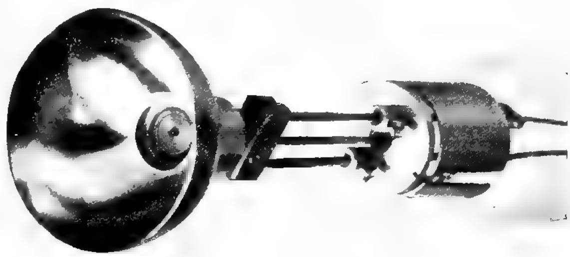
In the examination of baggage at customs ports the X ray has been of service in detecting false bottoms in trunks and chests used by smugglers and in revealing jewels and other valuables concealed in undutiable articles.

The manufacture of X ray apparatus and supplies forms an interesting and gradually increasing subdivision of the electrical industry. Formerly most of the vacuum tubes were imported from European countries, but the tubes made in the United States for several years past have been the best obtainable in the world.

The X ray tube produced a few years ago by Dr. W. D. Coolidge, of the General Electric Company's Research Laboratory, at Schenectady, N. Y., has been described by competent authority as an epoch making advance. Without it commercial X ray applications would be unduly expensive and it is doubtful if therapeutic results could be obtained so well.

The ordinary X ray tube, containing a small amount of gas, has a short life and its resistance is extremely unsteady, necessitating careful adjustment, which often is difficult. With the Coolidge tube the gas is exhausted as nearly completely as is possible and the current is carried by ions liberated from an incandescent cathode. The important factors in determining the amount of current that can be passed by such a tube are the area of the surface heated and the temperature; in other words, the number of ions liberated. When discharges pass through such a tube very little potential is developed until all of the ions are saturated. At this point the potential very rapidly rises from 600 volts, or so, to the capacity of the source. The Coolidge tubes are now being operated on very high tension circuits adjusted for constant potential regulation. This effects a uniform performance of the tube so far as quality of rays is concerned. By adjusting the current which heats the filament of the cathode, the number of milliamperes passing through the tube also can be accurately adjusted. If all of the gas is eliminated from the tube and the passage of current depends entirely upon the thermo-ions, the operation is constant. This is not true of any gas tube because of the constant changing of the gas pressure for various reasons and also because there is no saturation point in the gas tube. The initial breakdown, or starting potential, in the gas tube is usually higher than the running potential, sometimes four or five times as high, but in the Coolidge tube the break-down potential is small. No high potential is developed until all the ions are saturated.

Another important feature of the Coolidge tube is that it acts as a rectifier. If the target is kept reasonably cool, the tube can be connected directly to the terminals of a high tension transformer and will suppress the wave in the inverse direction. With most gas tubes the resistance is less in the inverse direction than in the running direction. It is necessary, therefore, to excite these tubes with a rectified current. When used with induction coils, even the inverse potential developed at each closing of the circuit by the interrupter is troublesome.



Cathode used for Obtaining Very Fine Focus for Dental Work, etc.

The terminology of the X ray and its applications, as officially sanctioned and adopted by a number of Röntgen societies, is as follows:

Roentgen—pronounced rent-gen.

Roentgen ray—a phenomenon in physics discovered by William Conrad Roentgen.

Roentgenology—the study and practice of the roentgen ray as it applies to medicine and surgery.

Roentgenologist—one skilled in roentgenology.

Roentgenogram—the shadow picture produced by the roentgen ray on a sensitized plate or film.

Roentgenograph (verb) — to make a roentgenogram.

Roentgenoscope — an apparatus for examination with the fluoroscopic screen excited by the roentgen ray.

Roentgenoscopy — examination by the means of the roentgenoscope.

Roentgenography — the art of making roentgenograms.

Roentgenize—to apply the roentgen ray.

Roentgenization — the application of the roentgen ray.

Roentgenism — untoward effect of the roentgen ray.

Roentgen Diagnosis—diagnosis by the aid of the roentgen ray.

Roentgenotherapy—treatment by the application of the roentgen ray.

Roentgen Dermatitis—skin reaction due to the too strong or too oft repeated application of the roentgen ray.

There is a rising tide of protest against the use of these terms and the hope has been expressed that they will soon be replaced by others. The name of Röntgen does not lend itself well to word building; it does not fall "trippingly from the tongue." A movement already is on foot to provide substitutes for these unwieldy words which will be correctly descriptive and easier to use.

Anode of the Standard Coolidge X-Ray Tube

THE J. G. WHITE ENGINEERING CORPORATION

There is in existence no organization which is more typical of modern progress in engineering than that known as The J. G. White Engineering Corporation, the operation of which constantly includes large development and constructive work in electrical, mechanical, civil and hydraulic engineering. James Gilbert White, head of the company, who was born in Milroy, Pa., August 29, 1861, was graduated from Pennsylvania State College with the degree of A.B. in 1882, and with the degree of Ph.D. from Cornell University in 1885; and became instructor in physics in charge of the Department at the University of Nebraska from 1885 to 1887. In the latter year he entered business life and engineering practice as president of the Western Engineering Company, serving in that capacity from 1887 to 1890.

He was with the Edison United Manufacturing Company in 1890, and in the same year he started in business as a contractor and engineer in New York City by organizing J. G. White & Co., Inc. He became deeply interested in engineering from the contracting and construction side and also, to a large extent, in financing engineering operations, especially those connected with public utilities. In 1903 the business of J. G. White & Company, Inc., was incorporated under the laws of the State of Connecticut. This company acts through its subsidiary, The J. G. White Engineering Corporation as consulting and constructing engineers, and also finances electric railways, electric light and power, gas and other public utility properties, and manages and operates such properties. The company, by capitalizing and organizing engineering ability, financial efficiency and managerial skill, has built up an enormous business, not only in the United States, but also in Canada, where a separate organization was operated for a time. A British branch was incorporated July 10, 1900, as J. G. White & Company, Limited, having its head office in London.

The company here established headquarters in New York and branches in Chicago and San Francisco, and year by year conducted large engineering operations in the construction of electric railways and other public utilities, and also became operating and consulting operating manager of a great number of large properties.

The various operations became so great and so widely distributed that on December 31, 1912, the company organized two separate companies—one, The J. G. White Management Corporation, to take over the department of operation and management of the many utilities in the company's care, and the other, The J. G. White Engineering Corporation, to take over the engineering and construction department of J. G. White & Company, Incorporated. The common stock of both corporations is held by J. G. White & Company, Inc.

The properties managed by J. G. White & Company, Inc., were nearly all planned, laid out, and constructed by the Engineering Department of J. G. White & Company, or by its successor, The J. G. White Engineering Corporation. Some idea of the extent of this engineering work may be gathered from the fact that the Management Corporation had under contract on June 1, 1917, public utility and railroad properties and industrial enterprises in the United States, Nicaragua, the Philippines and Cuba, including the Manila Electric Railroad and Lighting Corporation and its subsidiaries; the Helena (Montana) Light and Railway Company; the Eastern Pennsylvania Railways Company, of Pottsville, Pa., and subsidiaries; the United Light and Railways Company, and subsidiaries; the Associated Gas and Electric Company, and subsidiaries; the Augusta-Aiken (Georgia) Railway and Electric Corporation and subsidiaries; Pacific Railroad of Nicaragua; Kentucky Public Servive Company and subsidiaries; Southern Utilities Company and subsidiaries; the Poughkeepsie and Wappingers Falls Railway Company; Cardenas-American Sugar Company (Cuba); Matanzas - American Sugar Corporation (Cuba); Central Sugar Corporation (Cuba); Thornapple Gas and Electric Company of Hastings, Mich.; Cayuga (N. Y.) Cement Corporation; Philippines Railway Company, and several other companies.

The White enterprises represent the result of pioneer adventure into the field of organized engineering effort, and J. G. White & Company, Incorporated, was one of the earliest of the corporations which combined, under one organization, the engineering, financing and management of public utilities. It has become, with its British offshoot, the representative of world-wide development, largely electrical, in the creation of transportation, light and power facilities. Its success represents one of the marked achievements in the engineering profession, and has been chiefly due to the fact that its career has been created and directed by engineers of the highest attainments.

James Gilbert White, the founder of the business, is known as an able engineer and an equally able financier and executive. He is President of J. G. White & Company, Incorporated, the parent corporation of the White group; is Chairman of the Executive Committees of The J. G. White Engineering Corporation and of The J. G. White Management Corporation. He is also President of the Engineering Securities Corporation, Cardenas - American Sugar Company, and Investment Securities Corporation, all of New York; President of the Matanzas-American Sugar Company, and a director of many of the electric railway, light and other corporations which are under the management of The J. G. White Management Corporation. He is a member of the American Institute of Electrical Engineers, the American Society of Civil Engineers, American Society of Mechanical Engineers, and the New York Electrical Society. He is also a member of the National Civic Federation, the Pan-American Society of the United States, the Chamber of Commerce of New York; Vice-President of the Merchants Association of New York; member of the Pilgrims' Society, the Sons of the Revolution, American Museum of Natural History, American Society in London and other societies; as well as many clubs, including the Metropolitan, University, Recess, Midday, India House, Bankers, Automobile of America, New York Athletic and Cornell University clubs of New York, Ranelagh Club of London, Maryland Club (Baltimore), Sleepy Hollow Country, Greenwich Country and Columbia Yacht clubs and others.

The President of The J. G. White Engineering Corporation is Gano Dunn, one of the most distinguished of American electrical engineers. He was born in New York City on October 18, 1870, was graduated B.S. from the College of the City of New York in the class of 1889, receiving the degree of M.S. from that institution in 1897, and was graduated from Columbia University, with the degree of Electrical Engineer, in 1891. That university conferred upon him the honorary degree of M.S. in 1914.

Mr. Dunn began his professional career with the Western Union Telegraph Company, with which he was connected from 1886 to 1891; and after that with the Crocker - Wheeler Company. From 1898 to 1911 he was vice-president and chief engineer of that company. In 1911 he became connected with J. G. White & Company, Incorporated, as vice-president in charge of engineering and construction, and so continued until 1913, when, upon the organization of The J. G. White Engineering Corporation to take over the engineering and construction department of J. G. White & Company, Incorporated, he was elected to the presidency of that corporation. The company has steadily prospered under his active and skillful management. Mr. Dunn has long been recognized as one of the leaders in the engineering profession, and he is a member of and has held prominent positions in several of the most important engineering organizations of the country, having been president of the New York Electrical Society from 1900 to 1902; president of the American Institute of Electrical Engineers from 1911 to 1912; president of the United Engineering Society, 1913-1916; president of the John Fritz Medal Board of Award, 1914; vice-chairman of the National Research Council, 1917; chairman of the Engineering Foundation, 1915-1916; secretary of Electric Lighting and Distribution, International Electrical Congress, St. Louis, 1904, and a United States delegate to and vice-president of the International Electrical Congress at Turin in 1911. He is a member of the International Electro - Chemical Commission,

was a delegate from the American Institute of Electrical Engineers to the 2nd Pan-American Scientific Congress at Washington in 1915, member of the War Department Nitrate Commission, 1916-1918; and a member of the Engineering Committee of the Council of National Defense.

Mr. Dunn is an honorary member of the Association of Iron and Steel Electrical Engineers; Fellow of the American Institute of Electrical Engineers; Institute of Radio Engineers; member of the American Society of Mechanical Engineers, American Society of Civil Engineers, British Institution of Electrical Engineers, the Franklin Institute, and Illuminating Engineering Society, as well as the following: Pilgrims' Society, the Sons of the Revolution, and the Union, University, Fencers, Columbia University, Engineers', and Recess clubs of New York; the Cosmos Club of Washington, and the Engineers' Club of Philadelphia.

Mr. E. G. Williams, vice-president of The J. G. White Engineering Corporation since its incorporation in 1913, is a prominent civil engineer. He was born at Essex, Connecticut, in 1865, and was graduated from Yale (Sheffield Scientific School) Ph.B. 1887. His wide construction experience includes extensive steam railroad, engineering and construction, harbor developments in South America as well as in this country; mining in South America, water supply, filtration and sewage disposal, engineering and construction, heavy railway tunnel construction and highway engineering.

Since the formation of the corporation, Mr. Williams has had charge of all construction work, including many notable hydro-electric developments, railway work, steam power plants and more recently the construction of nitrate plants, aviation fields and other important work for the United States Government.

He is a member of the American Society of Civil Engineers, American Institute of Mining Engineers, Washington Society of Engineers, University Club of Washington, University Club, Engineers' Club, Yale Club, and Lawyers Club of New York.

Mr. Albert S. Crane, vice-president of The J. G. White Engineering Corporation, is a civil engineer best known for his design and engineering of hydraulic structures and power plants. He was born at Addison, New York, 1868, and was graduated from Cornell University, C.E., 1891. A varied experience with public hydraulic and sanitation systems both in this country and in Europe occupied the earlier years of his professional career. Later his work with the sanitary district of Chicago on the drainage canal, and the design and construction of its power plant and the power plant at Sault St. Marie, Ontario, brought him into prominence in hydroelectric development. Since 1905 he has been connected with The J. G. White interests during which time he has been responsible for the design of over 600,000 h.p. of hydro-electric developments.

Since 1913 Mr. Crane has been a vice-president of the corporation and in executive charge of the engineering department.

He is a member of the American Society of Civil Engineers, Boston Society of Civil Engineers, Western Society of Engineers, American Institute of Electrical Engineers, Engineers' Club, Lawyers' Club, of New York, and Engineers' Club of Brooklyn.

Mr. Henry A. Lardner, a vice-president of The J. G. White Engineering Corporation, is also a well-known engineer. He was born at Oconomowoc, Wisconsin, October 1, 1871, was graduated from the University of Wisconsin as B.S. in Electrical Engineering in 1893 and as E.E. in 1895. He has been with The J. G. White interests from 1894, and was manager of the Pacific Coast office 1908-1915. He is a Fellow of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the New York Electrical Society (past president), and the Engineers' and Lawyers' clubs of New York, Pacific Union of San Francisco, and California of Los Angeles.

WILLIAM S. ANDREWS

William Symes Andrews, veteran electrical engineer, was born at Saltford, Somersetshire, England, September 10, 1847. He was educated at a private school in Bath and at the Beckington Business College, in England, engaged in business life, coming to the United States in 1875. He had always been interested in electrical apparatus, and he was living in Newark, N. J., when an item in a local paper in November, 1879, aroused his interest and impelled him to visit the Edison Laboratory at Menlo Park. As a result he was employed at the Laboratory, 1879-1881; was superintendent of testing at the Edison Machine Works, New York City, 1881-1883; chief electrical engineer Edison Electric Construction Company, 1883-1886; general superintendent Marr Construction Company, 1886-1888; vice-president, secretary and treasurer Leonard & Izard Company, Chicago, 1888-1889; superintendent United Edison Manufacing Company, New York City, 1888-1891; technical assistant Edison General Electric Company, New York, 1891-1892; superintendent of Peterboro Works, Canada, of Canadian General Electric Company, 1892-1893; secretary and general manager Edison Electric Illuminating Company, Lancaster, Pa., 1893-1894; since then with General Electric Company in various capacities; now consulting engineer.

WILLIAM S. ANDREWS

He is a fellow of the American Institute of Electrical Engineers and of the Illuminating Engineering Society; member of the American Association for the Advancement of Science, National Electric Light Association, Electrochemical Society, the Franklin Institute, Philadelphia, Royal Society of Arts (London), Schenectady Historical Society, and Edison Pioneers.

ARTHUR L. ABBOTT

Arthur L. Abbott, an electrical engineer whose experience and practice have been pursued along constructive lines, worked his way into the profession because it offered so many problems to solve, and much opportunity for original work. He was born at Albert Lea, Minnesota, March 14, 1873, and after due preparation in common and high schools, he entered the University of Minnesota, from which he was graduated with the degree of Electrical Engineer in the Class of 1897. While in the University he received his initiation into the Delta Upsilon Fraternity.

After graduation he held three or four unimportant, routine positions until, in May, 1899, he entered the employ of W. I. Gray & Company, of Minneapolis, electrical contractors. At that time steel conduits for interior wiring had just begun to be used.

He has been especially interested in study and experiment in the field of illuminating engineering, and has also devoted much study to the problems of efficiency engineering as applied to the electrical contracting business. After a long connection with W. I. Gray & Co., in which he was superintendent of construction, he became associated with the Electrical Construction Company of St. Paul, Minnesota, of which he is Vice-President and Manager. He is a member of the American Institute of Electrical Engineers and of the Illuminating Engineering Society.

CYRUS O BAKER

CYRUS OSBORNE BAKER

Cyrus Osborne Baker was born in Newark, N. J., October 12, 1857, coming of good, old Puritan stock. The Baker family originally settled in Massachusetts and Long Island, finally arriving in New Jersey. Mr. Baker's great-grandfather lived at Springfield, N. J., during the Revolutionary War, and served as an officer in the Continental army.

When barely of age, young Baker, blessed with a sound education and good health, began his business career as a refiner of the precious metals, gold, silver and platinum, of which trio the latter had at that time received but little commercial application, outside of the chemical industries. Forming a partnership with his father, under the firm name of Baker & Co., he concentrated his energies on the factors of increased supply, improved quality and enlarged applications of platinum, with such success as to merit his general recognition as the pioneer developer of America's platinum industry. Subsequent to his father's death he reorganized and greatly enlarged the business of the Baker Platinum Works, continuing the same under his presidency as Baker & Co., Incorporated, of Newark, N. J., and New York City. Prominence and leadership in the industrial applications of platinum and intimate relationship for forty years with every phase of its utilization have indissolubly linked his name with this metal among its users in this country.

Platinum was first discovered in a Spanish mine in South America in the early part of the 18th century, but it was more than a century later, following the location of rich deposits of the metal in the Ural Mountains of Russia, before it began to acquire commercial importance. From the latter source fully 90 percent of the world's supply has since been derived, the average shipments of crude ore in recent years approximating 200,000 ounces, of which this country has perhaps absorbed nearly one-half in the arts and newly developed industries. Of the latter, the electrical early assumed major importance, which it has maintained amid constantly enlarging ramifications. Platinum possesses certain unique physical properties which aside from its scarcity give it intrinsic value, such as high melting point (1755° C.), low coefficient of expansion with temperature changes, great resistance to chemical attack combined with marked capacity for effecting chemical combinations between other elements by contact without itself undergoing change; in short it may be classed as a more noble metal than gold. These properties have made it an indispensable element in an endless variety of experiments preceding the development and in the final operative forms of electrical appliances of all kinds. Recognition of its special value in modern industry has so increased the demand beyond the available supply of the metal as to advance its price 1,500 percent above that obtained when first marketed by Mr. Baker. Substitutes of great variety have naturally been resorted to under these conditions, but no other single element or combination of elements has yet been found possessing its valuable properties.

Mr. Baker very wisely applied his energies to the development of an industry destined, as he foresaw, to play an almost vital part in many others. Thoroughly conversant with the subject, and with an attractive personality, he early acquired the acquaintance and trade of every one in the electrical field needing platinum. Incandescent lamp manufacturers were for many years the largest single users of platinum for leading-in wires, but with the curtailment of consumption in this industry others increased their demands in even greater proportion. Since the beginning of the late war the public generally has become acquainted with the real value of this metal in the development and efficient operation of essential industries—such as the production of chemical reagents needed in the manufacture of munitions, which necessitated the commandeering of existing supplies and restricted the use of the metal to purposes approved by the War Industries Board.

Mr. Baker's activities, however, were not confined strictly to commercial and industrial matters. His genial nature and high sense of honor made him an active leader for several years in many social and business organizations. He was a charter member of the New York Electrical Club, whose membership included many pioneers in the electrical industry.

Another society of quite different character, formed in 1885, is the National Electric Light Association, which has grown to be the largest body of its kind in the world, with a membership of over 12,000 officials and executives. To the affairs and councils of this organization during its formative period Mr. Baker contributed his constructive influence, in recognition of which the distinction of honorary membership was conferred upon him. As this Association expanded and the convention habit came into vogue Mr. Baker assumed the rôle of Master of Transportation, managing the arrangements for the long distance transportation of delegates so well that at the convention held in St. Louis in 1893, he was made the recipient of a silver loving-cup. Outdating these organizations is the New York Electrical Society, to which Mr. Baker long gave his earnest support. His influence in educational public works was also marked. He took a leading and official part in various great electrical expositions, such as that held under the patronage of the National Electric Light Association at the Grand Central Palace, New York City, in 1896, and another memorable demonstration of electrical progress occurring three years later at Madison Square Garden. Besides his principal business interests, he served as vice-president of the National State Bank of Newark, N. J.

Mr. Baker's death occurred June 13, 1918. His personality was of the finest, and one expression of his characteristic sociability is found in his long connection as an old-time member of the famous Lotos Club of New York City. His passing has meant a great loss to his associates and to the entire professional fraternity of which he was so honored a member.

BENJAMIN F. BAILEY

As engineer, educator, inventor and writer, Professor Benjamin Franklin Bailey, of the University of Michigan, occupies a place of honor and prominence in the electrical world. He was born in Sheridan, Michigan, August 7, 1875, and was educated in the public schools of Detroit, and in the University of Michigan. He was graduated with the degree of B. S. in Electrical Engineering in 1898; A. M. in 1901 and Ph. D. in 1907, and became a member of the honorary society of Sigma Xi, and of the Tau Beta Pi fraternity.

His first work was with the Edison Illuminating Company of Detroit, from which he went into the Testing Department of the General Electric Company at Schenectady, New York. He began his teaching career in the University of Michigan as instructor in electrotherapeutics, 1900-1901; became instructor in electrical engineering, 1901-1906; assistant professor, 1906-1910; junior professor, 1910-1913, and since 1913 has been professor of electrical engineering in the University of Michigan. He has been an important contributor to electrical literature, is author of "Induction Motors," "The Principles of Dynamo Electric Machinery," and numerous papers in the technical press, and is also author of "Induction Coils," a thesis presented for the degree of Ph. D.

In professional work he served as assistant engineer for The Arnold Company in the summer of 1906, and engineer with The Fairbanks-Morse Electric Manufacturing Company, in the summer of 1907, becoming chief engineer with that company from 1908 to 1910, and since then consulting engineer for that company. He has been consulting engineer and director of the Bailey Electrical Company, Grand Rapids, Mich.; consulting engineer of the Disco Electric Starter Corporation since 1914, and is now also consulting engineer and director of the Howell Electric Motors Company and other companies. He is the inventor of the "Internal Resistance" Induction Motor for the Fairbanks-Morse Electric Manufacturing Company, and developed electric starting and lighting apparatus with the Disco Electric Starter Corporation.

JOHN DUDLEY BALL

In the varied activities of engineering practice, professional literature, and technical teaching, Professor John Dudley Ball has, in ten years from graduation, attained a place of note and influence in the electrical field.

He was born December 8, 1882, attended district school and the Pontiac Township High School, in Illinois, then went into business activities and had some experience with the Lake Belt Machinery Company in Chicago while pursuing the mechanical engineering course at the University of Illinois, from which he was graduated in the Class of 1907, later, in 1915, receiving the degree of E. E. from that university.

On leaving the University he entered the service of the General Electric Company, working in the Testing Department, testing electrical machinery for two years, and after that was engaged for five years in research and development in the Standardizing Laboratory, and then for three years was a member of the Consulting Engineering Department. This service gave him a most thorough practical and technical training in electrical work, in close touch with the developments of electrical science. It covered a wide range of developing and consulting work, personal investigations conducted for Professor Charles P. Steinmetz, and a large amount of specializing on magnetics. His original researches led him to extensive contributions to technical literature in Europe and the United States, including results of original research, published by the Electro-Technik und Machinebau (Vienna), contributions to the Proceedings of the American Institute of Electrical Engineers, General Electric Review, Electric Journal, publications of the Franklin Institute, etc. He was awarded the Edward Longstreth Medal of the Franklin Institute for original research in 1917.

He is now dean of the electrical engineering department in the School of Engineering at Milwaukee, Wis., bringing to the chair the ripe results of ten years of thorough training, and of contact with the latest developments of electrical science. He is a member of the American Institute of Electrical Engineers and of the Milwaukee Electric League.

His activities have not all been professional. He had seven years of service in the Illinois National Guard; has made a comparative study of religious systems; has been deeply interested in astronomy. He is president of the Mayor's Civic Commission of the city of Milwaukee and secretary of the Public Affairs Dept. of the County Council of Defence. But outside of professional and family life his particular interest is along musical lines. He conducted an amateur symphony orchestra for seven years.

WILLIAM E. BARROWS, Jr.

No less essential to the advancement of electrical enterprise than the throbbing machinery of industrial plants is the maintenance of educational standards. William E. Barrows, Jr., is of a class of scientific men, who, though rather in the background of events, are charged with the important tasks of guiding the first steps of the oncoming generation of scientists and of keeping alive the detached and unprejudiced investigation of problems beyond the pale of present utilitarian affairs. As professor of electrical engineering in the University of Maine, Prof. Barrows returns to the scene of his undergraduate days where he was a student of electrical engineering. He came there from the public schools of Augusta, Me., the date and place of his birth were Feb. 20, 1878, Ludlow, Vermont, graduating in 1902 and supplementing his academic training by a two-year period of applied practice as student engineer in the Lynn (Mass.) works of the General Electric Company. His pedagogic labors date from 1904, when he became instructor in electrical engineering at the University of Pennsylvania. Two years later he joined the faculty of the Armour Institute of Technology as assistant professor of electrical engineering, leaving there in 1912 to become full professor and head of the electrical department of the University of Maine at Orono, where he also makes his home. Prof. Barrows is especially interested in the problems of illuminating engineering, to which subject he has contributed two

widely read books, "Electrical Illuminating Engineering" and "Light, Photometry and Illumination," the former published in 1908 and the latter in 1912. He is a member of the American Institute of Electrical Engineers, the Illuminating Engineering Society, the National Electric Light Association, and the Society for the Promotion of Engineering Education.

FREDERICK BEDELL

Professor Bedell, scientist and educator, combines to an exceptional degree the teaching gift with the faculty for fruitful research and invention.

He was born in Brooklyn, N. Y., April 12, 1868, was graduated from Yale University, A. B., 1890, and from Cornell University as M. S., 1891, and Ph. D. 1892; and he was elected to Sigma Xi, 1891. In teaching service at Cornell for the past twenty-five years he was instructor in physics, 1892-1893, assistant professor of physics, 1893-1904, and since 1904 professor of applied electricity.

Professor Bedell has been continuously active in research work, especially in the field of alternating currents, theoretical and experimental. He has patented improvements in telegraphy, telephony and power transmission, including a system for the joint transmission of direct and alternating currents.

He has been a member since 1892, and many years Fellow of the American Association for the Advancement of Science, was secretary of Section B (physics) in 1897; secretary of the Council in 1898, and general secretary of the Association in 1899. He became associate member in 1892 and member in 1896 of the American Institute of Electrical Engineers, and has served as vice-president, manager, and as a member of its most important committees. He is a member of the Aeronautical Society of America and in 1917 was member of a commission for planning the U. S. Schools of Military Aeronautics. He is a member of the American Physical Society, was one of the three editors of the *Physical Review* when that publication was controlled by Cornell University, 1893-1912, and since its control was transferred to the American Physical Society in 1913 has been its managing editor. He is author (with Dr. Albert C. Crehore) of "Alternating Currents, an Analytical and Graphical Treatment for Students and Engineers" (1892); and (with E. L. Nichols) of "A Laboratory Manual of Physics and Applied Electricity" (1894). In 1896 he published "The Principles of the Transformer," and his later works are "Airplane Characteristics," and "Direct and Alternating Current Manual." He has also contributed important papers to the proceedings of technical and scientific societies; contributed several scientific articles to Johnson's Universal Encyclopedia in 1895, definitions of electrical units to two editions of the Standard Dictionary; and prepared the electrical definitions for the recent revision of Webster's International Dictionary.

MURRAY CHARLES BEEBE

The University of Wisconsin has gained deserved prominence and repute for the special excellence and thoroughness of its technical courses, built up and maintained by a technical faculty of exceptionally high character and marked ability. One of this technical staff is Professor Murray Charles Beebe, alumnus of the University, long connected with its teaching staff and now holding, and adorning by his abilities the chair of electrical engineering in that institution.

He was born in Racine, Wisconsin, February 25, 1876, the son of Charles Seth and Selma Barsena (Eastman) Beebe. Through his father he traces descent from an ancestor who came from England and settled near Hartford, Connecticut, about 1640.

After a thorough elementary and preparatory training he entered the University of Wisconsin, from which he was graduated Bachelor of Science, with special honors and election to Tau Beta Pi and Eta Kappa Nu with the Class of 1897. His college fraternity membership is with Chi Psi.

Upon graduation he became connected with the teaching staff as instructor in electrical engineering in the University of Wisconsin, from 1897 to 1900. He followed this with valuable professional practice in

development work for George Westinghouse from 1900 to 1902, and after that from 1902 to 1905 was chemist and technical superintendent with the Nernst Lamp Company, at Pittsburgh, Pennsylvania.

In 1905 he was recalled to the department of electrical engineering of the University of Wisconsin, with which he has ever since been connected, being associate professor of electrical engineering until 1907, and since then professor of electrical engineering.

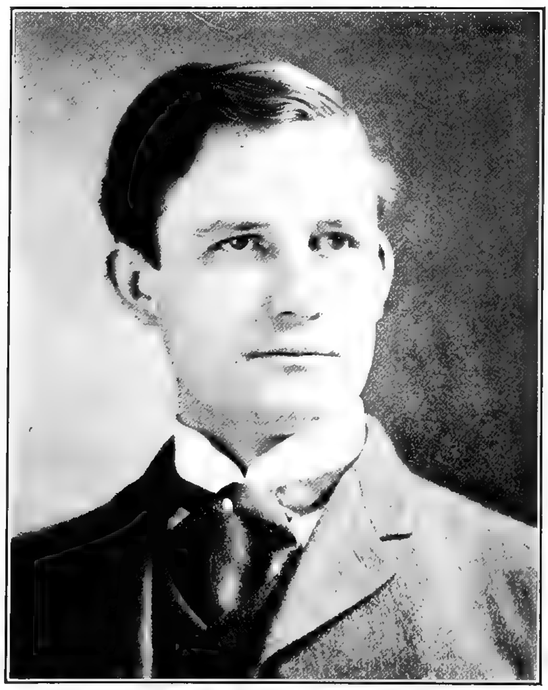
Professor Beebe, through his special identification with electric light problems, is a prominent and influential member of the National Electric Light Association, and is a member of its Committee on Relations with Educational Institutions. During the war he was granted leave of absence and engaged in research work on the engineering staff of the Western Electric Co. of New York. He is also a Fellow of the American Institute of Electrical Engineers, and a member of the University Club of Madison, Wisconsin.

BELL ELECTRIC MOTOR COMPANY

"If a man writes a better book, preaches a better sermon, or makes a better mouse-trap than his neighbor, though he build his home in the wilderness, the world will make a beaten path to his door," said Emerson. The case in point concerns electric motors as made by the Bell Electric Motor Company at Bell Terminal, Garwood, New Jersey. From there radiate paths to all corners of the country over which go Bell electric motors to animate the machinery of industry.

The Bell Electric Motor Company turns out two popular and distinct types of motors, invented, manufactured and patented by the two Bell brothers. These are the Bell Repulsion Induction Motor for single phase and alternating current and the Bell compensated Polyphase Motor for A.C. polyphase current. The first is a simplification of the single phase type of motor, entirely automatic in operation, dispensing with compensators and clutch pulleys, can be totally enclosed and made dust-proof—in fact, there are numerous improved features. The polyphase motor represents the most advanced type of polyphase machinery, highest in both power factor and efficiency, supplanting the old squirrel-cage motor. The claims made for the Bell polyphase motor cover many reasons in support of its superiority over preceding types.

Alonzo C. Bell and Thaddeus R. Bell are the sons of Alonzo Bell, who was assistant secretary of the Department of the Interior under Presidents Garfield, Arthur and Hayes, and a descendant of Francis Bell, the early founder of Stamford, Connecticut. Alonzo C. Bell, born at Washington, D. C., February 16, 1877, is the founder of the enterprise which bears his name. Educated in the New York public schools and devoting his nights afterward to studies at Cooper Union, he started in 1892 as an office boy at the old station of



ALONZO C. BELL

the Edison Electric Illuminating Company at Pearl and Elm streets. Five of the six ensuing years were spent in the inspection department under Mr. Arthur Williams. The study of electricity became his dominant passion and working on motors his

favorite occupation. It must have taken a deal of faith to establish the Bell Electric Motor Company in 1898 without any capital. He had his brother's help, and together they took a room on the fourth floor of 713 Broadway. Prospering there, they moved to Bleecker Street, and again to better quarters at Prince Street and West Broadway. Then the factory at Garwood was built. About 125 men are employed. Besides manufacturing motors, the company controls a process of electroplating patterns for foundry use, builds engine lathes, etc. Alonzo C. Bell is president and general manager of the Bell Electric Motor Company, the Bell Factory Terminal and the Powers & Robinson Foundry and Machine Company. Mr. Bell is a member of the American Institute of Electrical Engineers and the Power Club.

The career of Thaddeus R. Bell closely parallels that of his brother, with whom he has been co-inventor, business partner and maintainer of the fine reputation they have jointly established. He participates largely in the present active management of the business, being the vice-president and general manager of the company. He was born at Washington, D. C., December 25, 1879, and educated in New York schools, including Cooper Union night school. He is a member of the New York Electrical Society.

The New York offices of the Bell Electric Motor Company are at 30 Church Street.

JOHN ROBERT BENTON

One of the well known instructors who has given valuable service to the cause of engineering education is Dean John Robert Benton, of the College of Engineering of the University of Florida. He was born in Concord, New Hampshire, June 6, 1876. He was graduated from Trinity College, Hartford, Conn., with the degree of B. S. in 1897, and afterward attended the University of Göttingen, Germany, from which he received the degree of Ph. D. in mathematical physics. He had always been deeply interested in scientific studies, which led him to specialization as a physicist and mathematician.

He began his teaching career on his return from Göttingen as instructor in applied mathematics in Princeton University, and after that becoming instructor in physics in Cornell University until 1902. In 1905 he became professor of physics and electrical engineering in the University of Florida, which chair he still holds, and in 1910 he also became dean of the College of Engineering, in which position he continues, having had gratifying success in building up the applied science feature of the University to a favored place in the curriculum.

Professor Benton's services have been from time to time enlisted in work as magnetic observer for the United States Coast and Geodetic Survey, and also in varied phases of scientific work for the United States Naval Observatory, the United States Bureau of Standards, and the Geographical Laboratory of the Carnegie Institution, chiefly in connection with work involving problems in elasticity. In Trinity College he was a member of I. K. A., a local fraternity, recently absorbed by Delta Phi; he has also been elected to Phi Beta Kappa and Sigma Xi. He is a member of the American Physical Society, an associate member of the American Institute of Electrical Engineers, Fellow of the American Association for the advancement of Science, member of the Society for the Promotion of Engineering Education, and of the Florida Engineering Society.

ARTHUR S. BIESECKER

Arthur S. Biesecker was born at Newton, Lackawanna County, Pennsylvania, on August 12, 1878. After attending the public schools until sixteen years of age he entered Wyoming Seminary, where he prepared for college and also took a business course. In 1900 he entered Pennsylvania State College and was graduated in Electrical Engineering in the Class of 1904. The following year was spent in the Testing Department of the General Electric Company at Schenectady. In 1905 he accepted a position in the Elecrtical Department of the D. L. & W. R. R. at

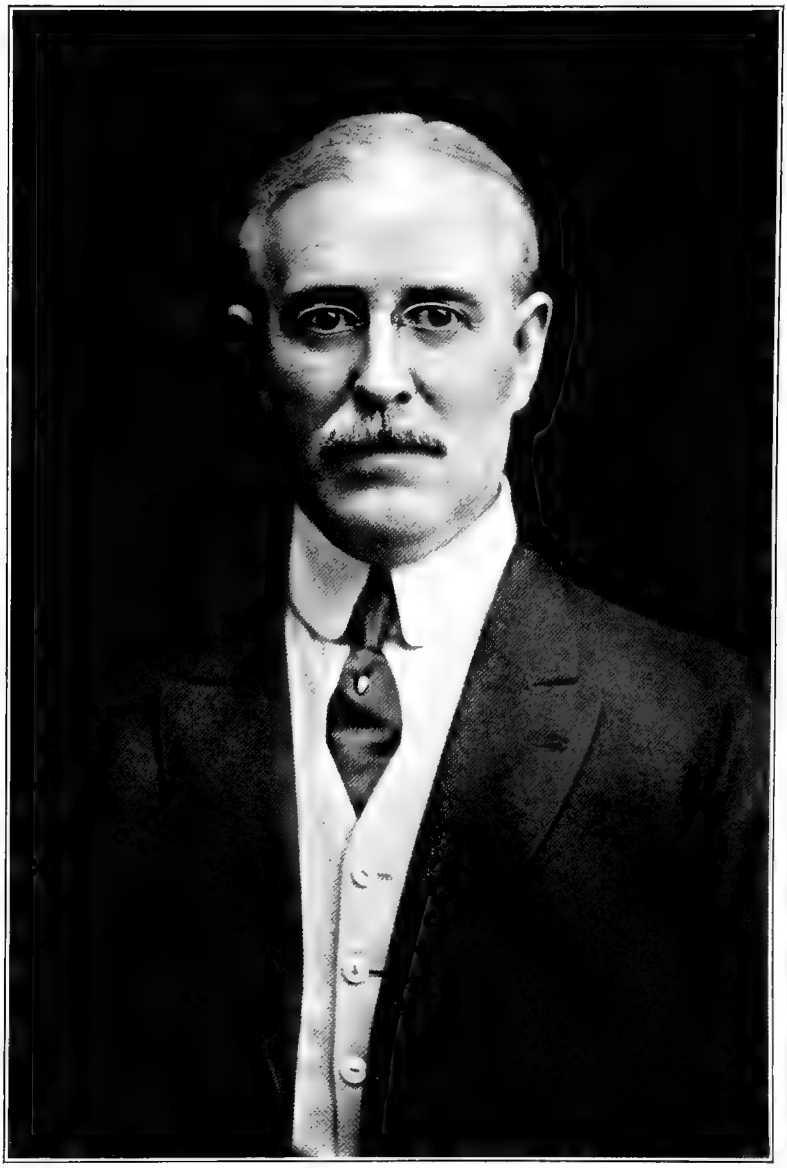
ARTHUR S. BIESECKER

Scranton, where he remained for eight years. Since 1913 he has been Electrical Engineer for the Scranton Electric Construction Company, which represents the General Electric Company in the anthracite region of Pennsylvania. In 1908 he married Miss Norma Decker, and has two children, Keith and Jean. He is a member of the Engineers Society of Northeastern Pennsylvania, the American Institute of Electrical Engineers, the Rotary Club of Scranton, and other organizations.

PUTNAM ASBURY BATES

Putnam A. Bates, whose wide experience as an electrical and consulting engineer led to his engagement by the city of New York in 1914 as chief electrical engineer, was born in New York City, December 27, 1875. His education at Columbia University, from which he graduated in 1897, was during the earlier days of the development of the electrical industry and his inclination turned naturally toward the class of engineering work in which the greatest progress was being made. During his college course in the School of Applied Sciences, he devoted himself intensely to experimental labor, research and original investigations, in addition to the prescribed courses. The product of this effort was an accumulation of practical information of such value as to win for him immediate recognition in the engineering field.

After finishing his collegiate course,



WILLIAM LORD BLISS

from which he graduated with the highest honors, Mr. Bates entered the engineering department of the Crocker-Wheeler Company, electrical engineers and manufacturers of electrical machinery. He acted in the capacity of engineer for this organization, later becoming an executive officer of the corporation. His duties gave him the opportunity to study at close range untold varieties of problems as it became his responsibility to determine the manner in which increased productivity could be created through a broader application of electrical appliances. These duties involved problems bearing upon water-power developments, electrification of railway systems, smelting and refining of copper and other metals, reduction of iron ore, fabrication of structural steel, manufacture of materials of many kinds, including food products and the betterment of agricultural conditions through the introduction of power. Activity in these fields soon showed direct results, by doubling the business of the company.

This intimate contact with America's leading industries gave Mr. Bates an abundance of information not to be had otherwise, concerning the most effective way of using electric energy, and in many instances his originality in planning the installations was responsible for the successful outcome where the possibility of such application had not previously been contemplated. Consequently these many problems of complex nature fitted him for a broad professional career, and in 1904 he severed his connection with the Crocker-Wheeler Company to establish a private practice as consulting engineer. He opened the offices since maintained at 2 Rector Street, New York City. Like other successful engineers, Mr. Bates has found his ideas, in the case of difficult engineering operations, can best be advanced by his being in a position to carry on the construction work with his own business organization. In 1915, therefore, he organized The Bates Company, engineers and constructors, of which corporation he has become president.

Mr. Bates, whose achievements have made him one of the most prominent of New York City's engineers in independent practice, has long been a member of many leading technical societies, which he has from time to time made the recipient of results from his professional experience. During the Great War his services were utilized by the United States Government in the carrying out of special electrical construction projects for the War and Navy Departments.

WILLIAM L. BLISS.

William Lord Bliss, Chief Engineer of the United States Light and Heat Corporation of Niagara Falls, was born in Brooklyn, N. Y., July 16, 1871. He entered the Adelphia Academy of Brooklyn in 1880, and remained six years, after which he entered the Polytechnic Institute of Brooklyn, in 1886, and remained five years. Completing the course in civil engineering through the junior year and the entire course in electrical engineering, he received the degree of Bachelor of Science in June, 1891. He then entered the senior class of Cornell University in 1891, and remained two years, completing the course in mechanical engineering and a year's post-graduate study, specializing in electrical engineering, and in June, 1893, received the degree of Master of Mechanical Engineering. In August, 1893, he entered the employ of the Riker Electric Motor Company of Brooklyn, N. Y., as electrician. Mr. Bliss had entire charge of designing standard generators and motors and much special electrical machinery. He designed and superintended the construction of car lighting apparatus built by the Riker Company for inventors of such machinery, and thereby became interested in this subject, which subsequently became his life work.

In April, 1895, he left the Riker Company to take a position with the Consolidated Gas Company of New York, assuming charge of photometric and burner work. He later conducted exhaustive experiments in isolated electric lighting plants, using gas engines as prime movers. He designed and built an experimental and demonstrating electric light plant for the gas company. This plant consisted of a large Crossley engine imported from Manchester, England, and was equipped with a starting device, which was the first gas engine starter he had ever seen. In May, 1897, he left the Consolidated Gas Company to devote his entire time to electric car lighting and the development of inventions made during the years of 1893 to 1897. After four years of continuous work, he had brought apparatus to such a satisfactory state as to warrant the formation of a company to exploit his inventions. He incorporated the Bliss Electric Car Lighting Company of New Jersey, with himself as president, but due to lack of sufficient capital, this company was operated only until March, 1904, when it was dissolved and a new company, having the same name, was incorporated in Wisconsin, with Mr. Bliss again as president. This new company was controlled by The Cutler-Hammer Manufacturing Company. The new Bliss Company exploited and marketed apparatus built upon Mr. Bliss' patents and designed by him. The Bliss Co. became the second largest concern in this line in the United States. His apparatus became known as the "Bliss System," and is thus spoken of all over the country today. In January, 1909, a consolidation of the Bliss Electric Car Lighting Company, the National Battery Company, and the United States Light and Heating Company of New Jersey, was effected, and a new company known as the United States Light and Heating Company of Maine was incorporated. This new company was organized to manufacture car lighting apparatus and storage batteries, and for a time operated factories in Milwaukee, Buffalo and New York. Mr. Bliss was appointed chief engineer of the new company by the president, the late William H. Silverthorn. In May, 1910, a new factory was designed and built at Niagara Falls, where all the work of the three previously mentioned factories was concentrated. Mr. Bliss was in complete charge of this new work, and finished and equipped the plant and operated it for two years until January 1, 1913. The company having taken on a new and extensive line of manufacture of self-starters for automobiles, it became necessary for him to drop manufacturing details and devote himself to further research and development, still retaining the title and authority of chief engineer. He has taken out over 80 United States patents and about one-quarter that number of applications are now pending in the Patent Office. Many of his inventions have been patented abroad. The majority of these patents relate to electric car lighting, while others relate to starters, storage batteries, railroad equipment and general lighting apparatus. The link suspension for mounting generators on car trucks and the ampere hour meter system of controlling battery charging in car lighting are covered by his patents. In 1915 he was awarded a diploma and silver medal by the Panama Pacific Exposition for his car lighting apparatus as collaborator with the United States Light and Heating Company. Mr. Bliss is a Fellow of the A. I. E. E., and is a member of the Society of Automotive Engineers, the American Electrochemical Society, the Association of Railway Electrical Engineers, the Chi Psi Fraternity and the principal railroad clubs. The U. S. Light and Heat Corporation succeeded to the business of the United States Light and Heating Company, after a receivership lasting a year, and he still holds the position of Chief Engineer with the new corporation, which has become the largest of the electric car lighting and storage battery manufacturing companies. The car lighting apparatus invented, patented, designed and built by Mr. Bliss has become the standard lighting equipment of the day on the railroads of the United States.

ANTHONY N. BRADY

ANTHONY NICHOLAS BRADY

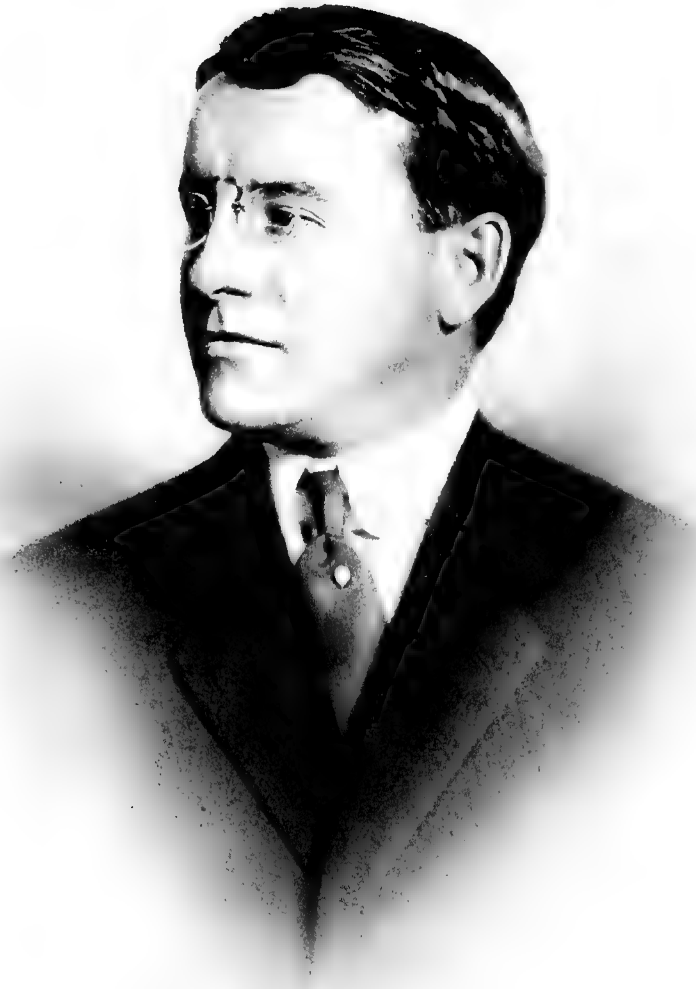
The creation of "public utilities," one of the developments of the past half century, was of vast social and economic import. It was the destiny of Anthony Nicholas Brady to write his name indelibly in the history of this phase of industrial progress, for he infused into the many public service companies and commercial enterprises whose affairs he watched over those qualities of efficiency and broad policy that have made them models of organization. Mr. Brady's life ended in London, England, July 22, 1913, after he had rounded out a long career of exceptional usefulness and distinction. He was born in Lille, France, August 22, 1841, of parents who had migrated there from Ireland and while still an infant he was brought to America, the family settling in Troy, N. Y., and there he received his education. Being a boy of unusual energy and ambition, he quickly founded a business for himself—the purveying of tea, which he carried on so successfully in Albany and vicinity that he acquired a moderate capital for investing in new enterprises. As a next step in his career he revived the operation of several granite quarries near Albany, putting them into a flourishing, profit-producing condition. The gas lighting companies of Albany and Troy were at that time the object of adverse criticism on account of mismanagement and faulty service, one reason for which was the defective processes of manufacturing employed. Mr. Brady, believing that he could effect a needed reform and enlisting the aid of ex-Governor Roswell P. Flower, Edward Murphy (later United States Senator) and E. C. Benedict, succeeded in securing control of the Albany Gas Light Company. One of the first improvements introduced was a gas-making process invented by the French chemist, Tessie du Montay, and improved in America by Jerzmanowski. As expected, it proved one factor in the subsequent excellent service rendered the public. The Chicago Gas Company, also suffering from difficulties, chiefly financial, was rejuvenated by Mr. Brady, who reorganized the property with the aid of the A. M. Billings Estate. His business horizon rapidly widened to embrace larger spheres of action, especially in the field known as "public utilities." In passing, it is of interest to note that he was the first competitor of the Standard Oil Company, supplying nearly all the oil sold in Chicago, through the medium of the Manhattan Oil Company of Lima, Ohio. Securing interest in the street railway systems and electric light companies of Albany and Troy, he was instrumental in having the former merged and extended and the latter raised to a higher standard of efficiency. Eventually he became a dominant personality in similar though larger undertakings at various points from New York west to Chicago. In the Eastern metropolis he was best known for his reorganization of the Brooklyn Rapid Transit Company, serving as chairman of the board of directors. With the acquirement of the Coney Island-Brooklyn line, the entire traction facilities of the borough were unified under one control. No less influential and resultful of benefit was his leadership as president and chairman of the board of the New York Edison Company, and president of the Kings County Electric Light & Power Company. About a half hundred other traction, lighting and industrial corporations numbered him in their directorates. This much seems a sufficient burden of responsibility for one man, yet Mr. Brady was equal to more. His status as a manufacturer involved the merchandising of commodities upon a large scale in both foreign and domestic markets. By way of illustration, he participated in the direction of such enterprises as the British Columbia Copper Company, the General Rubber Company, the International Cigar Manufacturing Company, the Rubber Goods Manufacturing Company, the Union Bleaching and Finishing Company, the Union Carbide Company, the United States Rubber Company and the United States Cast Iron Pipe and Foundry Company. At the time of his

death he was associated with the Cowdray group of English financiers, including the Mexican Oil Company, with whom he was in negotiation for the establishment of a line of tank steamers to carry Mexican crude oil to England for refining, and for the use of the oil-burning ships in the British navy.

There were certain characterictics of Mr. Brady's business career and personality more enduring in the memory of his friends and associates than the mere record of the many positions he held. First of all, he zealously sought to cultivate the best spirit between his organizations and the public, adopting every practical means to that end; and the same was true as applied to the internal relations of those organizations in which it was ever his aim to promote voluntary co-operation between employer and employee, based upon fair, equitable dealing. Among his clubs were the Down Town, New York Athletic, Manhattan, Automobile of America, Sleepy Hollow, and the Fort Orange Clubs; but these knew him little, for always he was essentially a home-loving man. At his home in Albany, in the charmed circle of family and friends, he was best appreciated. His friendship was treasured and the breadth of his intelligence admired wherever he went. Mr. Brady is survived by his wife Marcia A. Myers, to whom he was married August 20, 1867, and their children, Nicholas Frederic, and James Cox Brady, Mrs. Margaret Brady Farrell, Mrs. Marcia M. Brady Tucker, Mrs. Mabel Brady Garvan. Another daughter, Flora M. Brady Gavit, died October 3, 1912.

NICHOLAS FREDERIC BRADY

The chairman of the board of the Brooklyn Rapid Transit Company and president of The New York Edison Company is a leader and administrator of public service systems who has been foremost in demonstrating the efficacy of new ideals in industrial affairs. The policies of the many organizations in which the name of Nicholas Frederic Brady has appeared are examples of what is praiseworthy in a business career filled with onerous duties and responsibilities. Mr. Brady entered professional life well equipped by birth and education for the difficult tasks lying before him. He is the son of Anthony N. and Marcia A. (Myers) Brady, and was born at Albany, New York. The Albany Academy prepared him for entrance to Yale University, where he graduated with honors in 1899, having taken the A.B. degree. The ending of academic studies was only the beginning of others of more practical bearing, for immediately thereafter, becoming connected with The New York Edison Company, he devoted himself to acquiring a knowledge of the administrative problems of that industry. During the several years following he served as vice-president. His election to the presidency came in 1913 and he is now in direct personal charge of the company's affairs. The fruits of his leadership are evident in every department of the business and his policies have received the approval of the public as well as the industry. Principles of justice, co-operation and reciprocity are the foundation of the New York Edison Company's policies towards patrons and employees alike. As president of the Brooklyn Edison Company, Mr. Brady is at the head of a vast system of electric transmission and distribution for light, heat and power over a vast territory. Here, too, enlightened policy has accomplished much. The employees share in the profits of the company to an extent that has constituted them a considerable body of stock holders. Mr. Brady was chairman of the board of the Brooklyn Rapid Transit Company in a period of unprecedented construction uniting in one network of lines hundreds of miles of track serving the transportation necessities of the metropolis. His influence is felt in many and various enterprises, in which he is a director or trustee, including the following organizations: The American Tobacco Company; Consolidated Gas Company; National Surety Company; United Electric Light and Power Company; Brooklyn Heights Railroad Company; New York Consolidated Railroad



NICHOLAS F. BRADY

Company; Yonkers Electric Light and Power Company; Consolidated Gas, Electric Light and Power Company of Baltimore; Brooklyn Edison Company; Manhattan Refrigerating Company; Durham Coal and Iron Company, Durham, N. C.; Chattanooga and Tennessee River Power Company, and the United States Rubber Company. Other enterprises in which he is interested might be added to this sufficiently representative list of concerns.

Being so familiar with commercial electrical developments, it seems a foregone conclusion that Mr. Brady is interested in the progress of applied electrical science, attested by his membership in the American Institute of Electrical Engineers, the National Electric Light Association, and the New York Electrical Society. The range of his social activities is evidenced by membership in the New York Yacht, Atlantic Yacht, Yale, and New York Athletic clubs; the Railroad Club of New York; the Automobile Club of America, Rumson Country Club and others.

Mr. Brady was married in 1906 to Miss Genevieve Garvan of Hartford, Connecticut.

JOHN BALCH BLOOD

An engineer of distinction and a naval officer now in active service, John Balch Blood has long been identified with important electrical work. He was born in Newburyport, Mass., July 21, 1870, the son of George Whitefield and Mary Nelson (Balch) Blood. He is of old New England lineage, paternally descendant of Robert Blood, who settled in Concord, Mass., in 1635, and maternally from John Balch, who settled in Beverly, Mass., in 1630.

He was graduated from the Massachusetts Institute of Technology in 1890, with special courses in electrical engineering, and on graduation entered the employ of the Thomson-Houston Electric Company at Lynn, Mass., in its "Expert" course, on completion of which he went into the Railway Department and became assistant engineer in that department, in charge of the design of railway motors and their application. When the company was merged in the General Electric Company he remained assistant engineer with that corporation until 1896; then was engineer at Berlin, Germany, with the Union Elektricitats Gesellschaft, 1896-1897; was member of Blood & Hale, consulting engineers, Boston, 1898-1910; and after that with the Stone & Webster Engineering Corporation as Inspecting Engineer.

He served in the Massachusetts Naval Militia for nine years, retiring as Captain and Chief of the Naval Bureau in 1913. He went into service in the United States Navy as Lieutenant on mobilization for war with Germany, and was stationed as First Lieutenant of U. S. S. "Nebraska," executive officer of U. S. S. "Nokomis," and commanding officer of U. S. S. "Kwasind."

He has made special and intensive studies of ship design and navigation, and has worked out a new system of navigation whereby a ship's position can be taken direct from tables without trigometrical calculation.

He is a Fellow of the American Institute of Electrical Engineers; member of the American Society of Mechanical Engineers; associate member of the United States Naval Institute; past member of the Boston Society of Civil Engineers, member of the American Economic Association, the Army and Navy Club, of New York, the Ward Room Club, Boston, Sons of the American Revolution and other societies.

He has been active in civic matters in his home and native town of Newburyport, Mass., where he has served as Councilman and Alderman.

EDWARD P. BURCH

As a student at the University of Minnesota, in 1889, he found himself absorbed in the study of physics, and particularly the principles and application of electricity. In the summer of 1890 he worked as a wireman, armature winder and "calcu-

lator" for the Chicago Edison Company. The next year, under Professor Frederick S. Jones, now dean of Yale College, he stood at the head of his class in physics, and in the fall of 1890 was made undergraduate instructor in electrical engineering at the University. In 1891-1892 he took electrical engineering work under George D. Shepardson, the first professor of electrical engineering at the University of Minnesota, and was graduated as an electrical engineer, in 1892.

Horse car lines were then being changed to electric, and Burch realized the opportunities in this field, and decided that the electric railway would make a good life work. In 1891 he selected as a graduating thesis "Electric Railway Motor Tests," results from which are outlined in an A. I. E. E. paper of July, 1892. Following some hard work on the testing of interurban car equipment, design of feeder systems, and operation of power plans, he was made electrical engineer for the Twin City Rapid Transit Company, in 1893. During seven years' service for that company he had charge of the motor equipment and the steam and water power plants. Between 1892 and 1900 the company increased its electric track from about 100 miles to 218 miles.

In 1897 there was installed under his supervision one of the first power systems of its kind—embracing alternating current generators of 7,000-kilowatt capacity, at the St. Anthony Falls station, and three-phase underground transmission at 3,300 and 12,000 volts to four rotary converter substations for electric railway service in and near Minneapolis and St. Paul.

In 1900, with the increasing opportunity in heavy electric traction, he opened an office as a consulting engineer. His first clients were water power companies which sold and transmitted energy to electric street and interurban railways. Later he carried on engineering work for complete water powers, high-voltage transmissions, and converter substations, the principal work being at Minneapolis, St. Paul, Peterboro, Ontario, Seattle and Everett, Eau Claire, Winnipeg, and for the principal interurban railways in Iowa. His work in steam railroad electrification embraced the conversion of branch lines near Minneapolis and St. Paul, the Snohomish branch of the Northern Pacific Railway, and electrification reports on the Great Northern Railway's Cascade Tunnel, and on the Butte, Anaconda & Pacific Railway. In connection with consulting work, detailed inspections were made of the principal electrified steam roads in the United States and Europe. His book on "Electric Traction for Railway Trains" (McGraw, 1911), was the first of its kind to outline the history, status, and financial results of the electrification of steam railroads.

From 1911 to 1914, Mr. Burch was professorial lecturer, and afterwards associate professor of Railway Electrical Engineering at the University of Minnesota. In 1912, he was engaged by the Minnesota Railroad Commission in an advisory capacity on electric railways. In 1914, he was engineer in charge of the valuation of the Detroit United Railway; in 1915 as consulting engineer for the Detroit Electric Railway Commission; in 1916, on the track work of the Cincinnati Traction Co., and as advisory to the Department of Law for the City of Cleveland on the valuation of the Cleveland Electric Illuminating Co., and on the 1917 power contract with the Cleveland Electric Railway. In 1917 Mr. Burch was engaged as a consulting engineer at Minneapolis, and in war research work for the Minnesota Commission of Public Safety; and in 1918 on economic problems before a price-fixing committee of the War Industries Board.

RICHARD E. BREED

RICHARD E. BREED

The directing executive and organizer of the American Gas and Electric Company, Richard E. Breed, is one of the exemplars of efficient management of public utilities. Mr. Breed was born March 17, 1866, at Pittsburgh, Pennsylvania. After school days in Kentucky and a beginning in business at Cincinnati, Ohio, he made the technique of finance his especial province and figured with increasing frequency in financial transactions concerning important enterprises. The most interesting event ensued in 1906, when Mr. Breed, joined by S. Z. Mitchell, Anson W. Burchard, Harrison Williams, and Henry L. Doherty, formed the American Gas and Electric Company. The collaboration of these men brought the new organization into relationship with the interests of the General Electric Company. The incorporation was attended by the taking over of all the property and assets of the Electric Company of America, which consisted of gas and electric light plants throughout the country.

Under unified control the separate branches of the company's service have shown a steady increase of business, and as a whole the company has developed from year to year at a substantial rate of progress. The subsidiaries, or operating companies, are located principally in communities of Pennsylvania, Ohio, Indiana, Illinois and West Virginia. Among them are: The Atlantic City Electric Company, Atlantic City, N. J.; The Albany Water and Light Company, Albany, Indiana; the Central Power Company, Newark, Ohio; the Indiana General Service Company, Muncie, Indiana; the Jonesboro Water Company, Jonesboro, Indiana; the Lackawanna Light Company, Scranton, Pennsylvania; the Montpelier Utilities Company, Montpelier, Indiana; the Ohio River Power Company, Steubenville, Ohio; the Ohio State Power Company, Fremont, Ohio; the Rockford Electric Company, Rockford, Illinois; the Scranton Electric Company, Scranton, Pennsylvania; and the Wheeling Electric Company, Wheeling, West Virginia. A population of approximately a million is provided with electric service and the varied industries supported are innumerable. Items from the operating statistics of the combined companies show that between 1915 and 1917 the number of customers increased from 69,571 to 95,944, and the miles of high voltage transmission lines in operation for the same period increased from 269 to 609, with additional lines under construction. Mr. Breed is president of the American Gas and Electric Company and of all the subsidiary companies cited. S. Z. Mitchell is chairman of the Board; George N. Tidd, M. B. Feldman and M. F. Millikan are the vice-presidents; Frank B. Ball is secretary and treasurer. Though never a holder of political offices, Mr. Breed is an officer of long standing on the military staffs of the governors of Indiana. He is a Colonel on the staff of present Governor Goodrich, prior to which he served as Major under Governor Durbin, and Lieutenant-Colonel under Governor Hanley. In club circles he is a member of the Union League and Army and Navy Clubs of New York, the Union League and Corinthian Yacht Clubs, of Philadelphia, and the Sleepy Hollow Country Club.

WILLIAM P. BONBRIGHT & CO., INC.

The firm of William P. Bonbright & Co. was formed in 1895 and grew out of the private banking business which had previously been established by Mr. William P. Bonbright in Colorado Springs, Colo. In 1897 the growth of the firm's foreign business led to the establishment of a London office, and in 1902 the firm established its New York office at 15 Wall Street. In 1905 they moved to 24 Broad Street, where they remained until 1912, when they moved to 14 Wall Street. In April, 1917, the firm removed to new offices on the ground floor of the Equitable Building, at the corner of Nassau and Cedar Streets.

In 1912 the company was incorporated under its present title under the laws of the State of New York. In addition to its New York, London and Paris offices, it has branch organizations in Philadelphia, Cleveland, Detroit and Chicago.

As early as 1902 William P. Bonbright & Co. became interested in the securities of public utility companies, and it has financed many of the most notable of these. The firm clearly foresaw the wonderful development of the utility business and has specialized in its securities, although it has taken an increasingly important part in international finance, and in the last two years has effected foreign commercial credits of a gross amount of over $100,000,000.

AUSTIN BURT

Austin Burt, electrical engineer of notable accomplishment, was born in Detroit, Michigan, June 20, 1870. Grandson of William Austin Burt (Michigan pioneer, Territorial legislator, inventor of Solar compass), who as United States surveyor discovered the iron ore fields of Michigan.

Austin Burt was graduated M. E. in 1900 from Cornell University, with Sibley Prize in Mechanic Arts and election to Sigma Xi. He began business life at 13 as office boy for Crawford Livingston, president of the St. Paul Gas Light Company. He spent his sophomore-junior vacation in the engineering department of the Pillsbury mills, Minneapolis, was chief engineer of a blast furnace at Spring Valley, Wis., at the close of his junior year, and later was for five years with the Edward P. Allis Company.

At request of President M. W. Bartlett, he undertook the management of the Cedar Falls (Iowa) Electric Light Company to save it from impending bankruptcy, and in two years sold it, on terms that saved the entire investment, to the Citizens Gas and Electric Company, of Waterloo, Iowa, which elected him, in 1902, manager of the combined plants. The company's growth under his management is indicated by increase of consumers from 725 to 6,075; motors connected from 32 H.P. to 5,069 H.P.; plant output from 289,700 kilowatts to 10,255,000 kilowatts; station capacity 433 kilowatts to 4,200 kilowatts. A new plant of 20,000 kilowatts capacity has just been built under his supervision together with 200 miles of transmission line, serving eighteen other towns and cities besides Waterloo. Mr. Burt has also had much experience in steam turbine engineering, and in designing and installing a combined light and power underground system for Waterloo.

He is past president of the Iowa Electric Light Association and Iowa District Gas Association; Fellow of the American Institute of Electrical Engineers; member National Electric Light Association, American Society of Mechanical Engineers, State Historical Society, Board of Trade, Chamber of Commerce, Golf and Country Clubs; past president Board of Education, trustee Congregational Church, Y. M. C. A. and Y. W. C. A.; vice-president Public Library Board; president Rotary Club and Bunker Hill Chapter Sons of American Revolution; Knight Templar Mason, and Chancellor Commander Knights of Pythias, and vice-president of the Social Welfare League.

WALDO CALVIN BRYANT

Waldo Calvin Bryant was born at Winchendon, Massachusetts, on December 17, 1863, the son of Calvin T. and Almeda (Dexter) Bryant. He is of English ancestry, tracing his descent back to the 13th or 14th century. The American branch of the family owes its origin to Stephen Bryant, who emigrated to America in 1632 and settled in Plymouth and Duxbury. He was also the progenitor of the poet, William Cullen Bryant, and members of this family served as officers in the War of the Revolution. The Bryants have remained in and about the State of Massachusetts since Stephen Bryant's time. At the age of fourteen Waldo began to learn the machinist's trade at the shops of Baxter D. Whitney, of Winchendon, by working during his school vacations. At the age of sixteen, after finishing his course of study at the grammar school, he entered Cushing Academy, at Ashburnham, preparing for the Worcester Polytechnic Institute. He was graduated from that institution in 1884, at the age of twenty, with the degree of Bachelor of Science. He immediately entered the employ of the Thomson-Houston Electrical Company in their expert department at Lynn, Mass. He remained there one month, and was transferred to Bridgeport, Conn., as assistant to George Cutter, to operate the local electric light plant, remaining there until the spring of 1885, when he went to Waterbury to take a similar position with the Waterbury Electric Light Company. He remained in Waterbury until October, 1888, when, having invented the Bryant Push and Pull Switch during the summer of that year, he went to Bridgeport, and started in the business of making electric light supplies under the name of The Bryant Electric Company. Starting this business with a very small capital, he took out several patents on electric lighting devices, and continued their manufacture until July, 1889, when he incorporated The Bryant Electric Company, with a capital stock of five thousand dollars. The business grew from that time to its present proportions, having now a capitalization of two million dollars, and specializing in the manufacture of sockets, switches, and wiring devices used in incandescent lighting, both in this country and abroad.

The Bryant Electric Company has one of the largest plants in Bridgeport. It employs 1,500 hands when running full, and the buildings at State and Organ streets are four stories and basement, occupying nearly an entire city block, and having a total of 340,000 feet of floor space. The company has its own offices in New York City, San Francisco and Chicago.

Mr. Bryant is president, treasurer, general manager and director of the concern. He is also president, treasurer, general manager and director of The Perkins Electric Switch Manufacturing Company, a director in the First Bridgeport National Bank, trustee of the People's Savings-Bank, vice-president of The Siemon Hard Rubber Corporation, and a director in the Bridgeport Hydraulic Company, the Bridgeport Brass Company, the Bead Chain Manufacturing Company, and the Bridgeport Hospital, the Boys' Club and the Public Library Board. On February 19, 1918, Mr. Bryant was called to the service of the War Department of the United States Government as District Chief of Ordnance for the State of Connecticut and four counties in Western Massachusetts, having charge of the production of munitions, guns, etc., for that district. He is a member of the Union League Club of New York, University Club, New York, of the Bankers' Club, the Engineers' Club, the New England Society, and the American Institute of Electrical Engineers, in New York, of the Brooklawn Country Club, the Black Rock Yacht Club, the University Club, and the Algonquin Club of Bridgeport; and of the Metabetchouan Fishing and Game Club of Canada, and the Fisher's Island Sportsmen's Club of New York.

He is married and has two children: Waldo Gerald, born July 30, 1891, and Doris, born March 26, 1902.

ANSON W. BURCHARD

In a vice-president of the General Electric Company one expects to find a superior order of executive ability cultivated by extensive experience. The sequence of events in the life of Anson W. Burchard proves the supposition correct. Mr. Burchard is a native of Hoosick Falls, New York, born April 21, 1865. Completing his studies at the local high schools he matriculated with the favorite old Alma Mater of engineering science, the Stevens Institute of Technology. The institution of which he is now a trustee, graduated him in 1885 with the degree of mechanical engineer. With a similar professional designation, and in the same year, he connected with the J. M. Ives Company, engaged in steam and general factory engineering at Danbury, Conn. The transition from technical to executive position followed in 1891, when he became treasurer and manager of the T. & B. Tool Company of

WINTHROP C. BUSHNELL

Danbury, continuing there almost to the end of the century. At this point his chief interest was temporarily diverted to the mining of copper. From 1900-1902 he was vice-president of the Cananea Consolidated Copper Company, operating mines at Cananea, province of Sonora, Mexico. He soon returned to the destined channel of his labor, which has widened greatly since the year of 1902 when he joined the organization of the General Electric Company. Until 1904 he was comptroller at their headquarters in Schenectady, at which early date he became assistant to the President, a no less signal acknowledgment of capacity than his election in 1912 to be vice-president. Mr. Burchard's counsel is sought by numerous interests outside the immediate sphere of his activity, particularly in the field of electric power development. Besides being a director of the General Electric Company, he is on the boards of the American Power & Light Co., the American Gas & Electric Company, the Worthington Pump and Machinery Corporation, the Western Power Corporation, the Central States Electric Co., the Republic Railway & Light Co., the Schenectady Illuminating Co., the Mohawk Gas Co., Mahoning and Shenango Railway & Light Co., and the Electrical Utilities Corporation. Nor are his electrical affiliations all strictly business. He keeps abreast of engineering achievement in every department through the fraternal associations of one deeply concerned in the welfare of his profession. He is a member of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, American Society of Civil Engineers, and the Iron and Steel Institute of Great Britain. Catholicity of taste in recreative diversions accounts for his membership in many clubs, including the Metropolitan, University, Bankers, Railroad, Recess and others of like character. As a keen follower of outdoor sports, he is also on the roster of the Riding, Automobile, Sleepy Hollow, Piping Rock and Westchester Country clubs.

WINTHROP G. BUSHNELL

Winthrop G. Bushnell, of New Haven, Conn., has been active in the development of public utilities in southern New England since 1890. Working his way through Yale College, he graduated in 1888, and a few months thereafter identified himself with the Edison and later with the General Electric interests in southern New England, in the practical applications of electrical machinery for central station light, power and railway service.

Mr. Bushnell's chief contribution to this development has been in perceiving the intrinsic value of certain properties, which he has purchased and improved in accordance with the best engineering practice. In 1905 he bought the control of the New Milford (Conn.) Power Company, which had a partially completed 6,000 kw. hydroelectric plant of 110 feet head on the Housatonic River. This company had contracts to supply electric power at Waterbury and New Britain for a period of thirty years. By wise and constructive methods he improved the property until its demonstrated value attracted purchasers, to whom he surrendered it at a substantial profit.

For more than half a century the old Falls Village Water Power Company at Falls Village, Conn., had been idle and abandoned. He purchased it and later merged it into the Connecticut Power Company with the New London Gas and Electric Company; and under the guidance and control of Stone & Webster, the Connecticut Power Company, of which he is vice-president, has now become one of the foremost lighting and power properties of the State, supplying northwestern Connecticut, and—either at wholesale or retail—Torrington, Winsted, Thomaston, Bristol and Middletown. The company also supplies electric power at wholesale to New Britain and Hartford through the existing local companies.

Shortly after the Spanish-American War Mr. Bushnell purchased the lighting and power plant at Camaguey, Cuba, the largest inland city, rebuilt and enlarged the plant and sold it several years later to Canadians who wished to install a trolley

system in that city. He was also associated for several years with the late Alden M. Young, of Branford, one of the pioneer builders of trolley roads; but on close study he found that many trolley properties were not as substantial as they should be, and he disposed of all such investments advantageously and in time to escape financial loss.

During the World War Mr. Bushnell was chairman of the State executive committee in 1917 of the Y. M. C. A. War Work campaign, whose State budget was $700,000. Connecticut was the first State to secure its quota and then raised as much more. He was chairman of the State executive committee for the United War Work campaign in November, 1918, and in this capacity helped to raise $4,300,000, which was eighty per cent. more than the State's quota; only one northern State, Delaware, exceeded Connecticut's percentage of oversubscription in this National campaign. Ex-President William Howard Taft was secured by Mr. Bushnell to open both the Red Triangle and the United War Works campaigns and gave them such an impetus at the start that the State conference of leaders voted unanimously to accept and raise twenty-five per cent. more than the State's quota. The people of Connecticut responded most generously, especially in the latter campaign, in recognition of the heroic work of the 26th Division which had been in the thickest of all the fighting by the American forces in France.

That Mr. Bushnell inherited some vision and constructive ability is indicated by the fact that his father, the late Cornelius S. Bushnell, was responsible for the financing and quick construction of Capt. John Ericsson's Monitor, the first turreted warship, whose victory over the Confederate Merrimac, March 9, 1862, was the turning point in the naval affairs of the Civil War. He was also one of the builders of the Union Pacific Railroad.

Mr. Bushnell lives in New Haven. He is president of the New Haven Country Club and a member of four other golf clubs. He is a member of Center (Congregational) Church, a director in the local Y. M. C. A., and a member of both the Union League and Railroad Clubs, of New York City.

FRED BRAINARD COREY

Engineering, invention, salesmanship and sundry other occupations are united in the chronicle of Mr. Corey's professional work. Fred Brainard Corey was originally a New York man, born at Homer, September 28, 1869, taking up electrical engineering studies at Cornell University and graduating in 1892 with the degree of mechanical engineer. Immediately thereafter he went into the employ of the Elektron Manufacturing Company, of Springfield, Mass., makers of the once popular Perret electric motors and generators. Several months' intensive training in their office and factory departments fitted him to become the Eastern New England representative at Boston, and he thus acquired early a practical sales and engineering experience. He is now efficiency engineer of the Pittsburgh Valve & Fittings Company, making his home at Barberton, Ohio. But during the intervening years he was active in a wide range of endeavor, serving successively the A. B. See Electric Elevator Co., as electrical engineer, the Springfield Elevator & Pump Co. as secretary and superintendent, the General Electric Company as designing engineer, and the Union Switch & Signal Co. as engineer of inspection and tests. Mr. Corey's inherited instincts, coupled with his first studies in physics, bred a penchant for invention which has been cultivated to the extent of some seventy-eight United States patents (others pending) taken out on numerous electrical and mechanical devices, for the most part relating to electric and steam railway operation. Engineering subjects form the content of articles which he frequently contributes to general and technical publications, and he has delivered timely lectures of similar character before professional societies. Mr. Corey is a Fellow of the American Institute of Electrical Engineers and the American Association for the Advancement of Science, a member of the American Society of Mechanical Engineers; and a long line of Colonial ancestry brings him into the Sons of the American Revolution.

CHARLES DAY

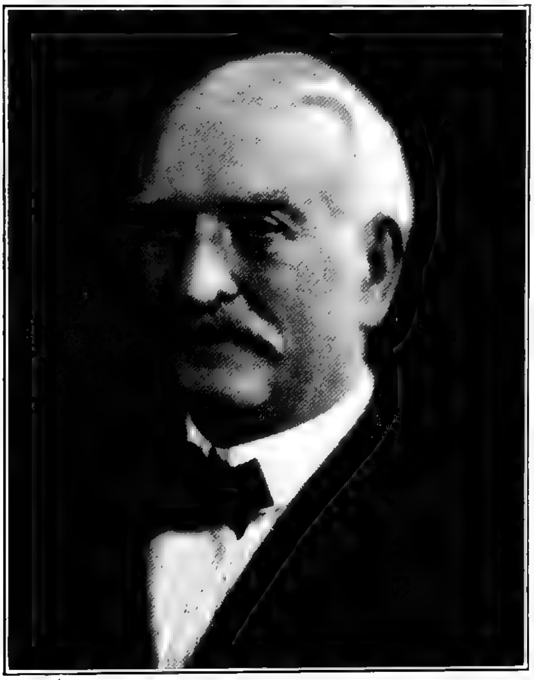
JOHN E. ZIMMERMAN

Day & Zimmerman, Inc., Philadelphia, Designing, Constructing and Operating Engineers

After the discoverer, the inventor and the manufacturer had brought their offering of electricity and the apparatus for its application to the world's work, came those whose function it was to assemble the various elements so as to meet the specific industrial and public needs. The development of the large central power station, with its transmission system and its network of distribution lines, has unquestionably been the most noteworthy achievement in this line. This function came to embrace the multitudinous factors involved in the correct estimate of the amount and character of business obtainable and the provisions which should be made for the supply of power; the selection of the power plant site, with due reference to such matters as water and fuel supply, transmission requirements, etc.; the design and construction of buildings, transmission and distribution systems and installation of equipment. Then, in order to make their work more effective, the engineers by degrees assumed the functions of actual operation. The present-day engineering organization's activities therefore will often be found to include not only experts in preliminary determination of requirements, in design and construction, but men who install and supervise the detail methods of production, distribution, securing new business, dealing with customers; men who dictate the utility's policies concerning public relations, make rates, deal with competitive situations and even take an active part in financing the company.

A. J. DeCAMP

Back in 1881, about the time the Brush Electric Light Company was empowered to provide electric lighting for the city of Philadelphia under the first ordinance passed for such a purpose, the company acquired the services of a young man who was to become one of its staunch pillars. A. J. DeCamp effected an entrance into the



A. J. DeCAMP

electrical fold by a policy curiously strange to the ways of modern youth, but then the business ways of 1920 seem less direct and simple than those of 1881. However that may be, Mr. DeCamp, when he joined the Brush Electric Company, was minus electrical experience though plus genuine enthusiasm and confidence in himself, which he transmitted to certain prominent executives of the day, including the late Thomas Dolan, who started him off with the "Let-us-see-what-you-can-do" injunction. He did not ask for any salary and he did not get any. The powers somehow forgot to put him on the payroll, but in the meantime he was living on the accumulated savings of his early thrift, and rapidly assuming important responsibilities in the business management of the company. He actually directed others whose salaries ran into substantial figures and handled large sums of money while still without a cent of remuneration for himself. Of course the company was awakened to this fact at the end of a year or so and adjusted matters to the satisfaction of all concerned. Since then Mr. DeCamp has served continuously in the capacity of secretary and general manager until recently, when he ostensibly retired. Lifelong habits are not easily cast off by a business man of his school.

In point of fact he is still at his desk, active, hale and hearty. The Brush Electric Light Company and its successor, the Philadelphia Electric Company, stand in his debt for years of sterling service, during which he has been instrumental in promoting the healthy growth of the business.

Mr. DeCamp is country bred, of French Huguenot stock, born at Georgetown, Burlington County, N. J., April 2, 1842, and raised on his grandfather's farm. He arrived in Philadelphia in 1859 and apprenticed himself to Sharpless Brothers, a wholesale drygoods house, remaining with them for eight years. Then he took a nine-year term in the grocery business, followed by five years of experience in insurance. He had the old-fashioned Yankee versatility and adaptability, and thus equipped won an honored place in the electrical fraternity, as told above. Mr. DeCamp has been a lifelong Republican. He has never become a principal in political struggles, but he has served one term in the Philadelphia City Council. He is a member of the Union League Club of Philadelphia and was formerly member of leading clubs in New York. In ways of diversion he became known for the skilled use of gun and rod.

Mr. DeCamp's office is at 1000 Chestnut Street, Philadelphia.

KERN DODGE

KERN DODGE

As a consulting engineer, Kern Dodge has rendered service to more than five hundred clients. A space of nearly twenty years of broad experience is covered, from the time when he came a partner in the firm of Dodge & Day, to 1912, when he sold his interest in that firm, and from then to date in his independent practice. Industries of Philadelphia and vicinity in particular, and of the country in general, have many cases in which Mr. Dodge has been concerned, and can testify to the excellence of his judgment and constructive ability. His expert knowledge has been applied to the design and layout of industrial plants and public utility properties and to the supervision of their construction. This has included work of especial note on the Panama canal. There are a number of industrial enterprises with which he is connected as a director or otherwise. Two of these are the Link Belt Company and the Vacuum Refrigerator Company.

Among the first tasks undertaken by Mr. Dodge were the installations in 1901 and 1902 of variable speed control of motors for machine tool driving. As instance, four-wire multi-voltage systems were installed in the Link Belt Company plant and that of the Jeanesville Iron Works Company. The adaptation of modern electrical methods to industrial processes, and the modernizing of plants was one interesting phase of his earlier career. A great deal was accomplished in the beginning by re-designing old machine tools for the installation of individual motor drives. The former, in addition had to be strengthened to withstand the new requirements brought about by the introduction of high-speed steel. During the same early period, elaborate and exhaustive tests of high-speed steels were conducted for the purpose of meeting the new demands of machine tool design. The evolution of machine tool practice was then at a revolutionary stage, affecting the whole range of metal manufacturing processes.

The Dodge family is one of long standing in America, calling to mind names associated with science and letters. The father of Kern Dodge was James Mapes Dodge, manufacturer and engineer and a past president of the American Society of Mechanical Engineers. A great-grandfather was Prof. James J. Mapes, an American scientist of distinguished attainments, and there was Mary Mapes Dodge, a grandmother, who was the originator and editor of the St. Nicholas Magazine.

July 20, 1880, in Chicago, Kern Dodge was born. He was a student at the Germantown (Philadelphia) Academy and later at the Drexel Institute, coming out with the class of 1901. Even in his school days, Mr. Dodge displayed an omnivorous appetite for work and an absorption in advanced problems of electrical science that was hardly short of precocious. During the four years preceeding graduation, he was assiduously laboring before and after class hours at the electric plant of the Link Belt Company at Nicetown. He was given the entire responsibility and labor of the wiring and of the installation of motors. Already to his credit was the building of small motors and dynamos up to ¼ H.P., and of one dynamo of 2½ K. W. which, it transpired, gave service from 1895 to 1915 and is said to still be in good condition. Prior to 1897 he was accepting house wiring commissions. He could experiment without wires, too, and very successfully, constructing a wireless telegraph apparatus in 1898 that operated over a distance of 1,000 feet.

Mr. Dodge has never confined his energies to narrow boundaries. The brief but intensive struggle to adjust the country's life and industry to a European war found Mr. Dodge centering his attention upon the crucial problems of munition production. He had strong support for the stand he took in advocacy of a government civilian rather than military organization in control of the munitions industry.

Mr. Dodge belongs to many scientific societies and clubs, among which are: The American Society of Mechanical Engineers; American Institute of Electrical Engineers; Illuminating Engineering Society; Engineers' Club, of New York; New York Electrical Society; Franklin Institute (of which he is manager), Engineers' Club, Union League Club, Sea View Country Club and City Club of Philadelphia; also the Aero Club of America. His offices are in the Morris Building, Philadelphia.

GLENDOWER DUNBAR

The city of Seattle, Washington, justly boasts a municipal electric system without parallel in the country. It comprises a plant valued at $8,000,000, which renders service to 55,000 customers, including two hydro plants and one steam plant having a combined capacity of 30,000 kw. This, America's most ambitious municipal project of its kind, has been created entirely since 1904, and among its creators the name of Glendower Dunbar ranks high. Every deed of his professional career has been as a milestone in the rapid extension of the Seattle Municipal Light & Power System; its beginning was his beginning and its growth up to date (1918) finds him appointed assistant superintendent while continuing in the post of chief electrical engineer assumed in 1911. His first task as a young man fresh from college, was upon transmission line construction. He entered the machine shop, in due time becoming foreman, and from there was transferred to the general offices, where he became chief electrical rate clerk. Through the medium of his attainments after he was later promoted to be assistant electrical engineer, it was but a step to his still greater present responsibilities. Probably no man knows more intimately than he the many sided problems involved in the success of such an undertaking. His part in this one has been described in detail in Volume 3 of the Official History of Seattle. Mr. Dunbar is a native of Michigan, born Dec. 16, 1880, at Newburg, but he owes both education and opportunity to his adopted State. As early as 1896 he was clerking in a western lumber mill. Education and industry went hand in hand, for during his school days he was working betimes in a newspaper office, in a grocery store, and in his father's hardware business. At the University of Washington, from which he was graduated in 1904, he was president of his class in the senior and junior years. Mr. Dunbar is a Member of the American Institute of Electrical Engineers and the Municipal League of Seattle.

ELECTRIC BOND AND SHARE COMPANY

Electric Bond and Share Company occupies a prominent position in the public utility field. It is both a financing and investing company and acts as fiscal agent, engineering and operating manager for companies in which it is interested. It has organized and acts as fiscal agent for several successful holding companies; it owns various amounts of securities in a large number of public utility companies, and it maintains an extensive operating and engineering staff. While it is interested in companies operating all kinds of public utility service its principal field is the electric light and power industry.

The company was incorporated in 1905. It began business with a capital stock of $4,000,000, equally divided between preferred and common shares of a par value of $100 each. The amount of capital stock has gradually been increased, until now there is outstanding a total of $17,000,000, one-half being preferred and one-half common stock. All of the common stock is owned by the General Electric Company. The company also has a surplus in excess of $4,000,000, so that its total paid-up capital stock and surplus aggregates more than $21,000,000.

During the first full business year of the company its gross income was $483,243. For the year ended December 31, 1917, its gross income was $3,140,020. From the beginning of business up to December 31, 1917, gross income aggregated $15,745,953 and net income $11,559,066. During this period dividends amounting to $2,627,639 were paid on the preferred stock and $5,425,222 on the common stock. The company's surplus and undivided profits at the close of business December 31, 1917, after reappraisement of securities and the creation of a reserve fund, amounted to $4,393,665.

Among the principal companies for which the Electric Bond and Share Company acts as fiscal agent on November 1st, 1918, at which date the figures in this article were prepared, are the American Power and Light Company, American Gas & Electric Company, Utah Securities Corporation, Lehigh Power Securities Corporation, Carolina Power & Light Company

and National Securities Corporation and all the subsidiaries of these companies.

American Power & Light Company, the largest of the groups of properties for which the Electric Bond and Share Company acts as fiscal agent, controls the Kansas Gas & Electric Company, the Pacific Power & Light Company, the Portland Gas & Coke Company, the Nebraska Power Company and the Southwestern Power & Light Company. These companies, either directly or through controlled companies, serve a total of 194 communities, of which 174 are supplied with electric light and power. Among the cities served with electric light and power or gas, or both, by the American Power & Light Company subsidiaries are Portland, Hood River and Astoria, Oregon; Walla Walla and Yakima, Wash.; Lewiston, Idaho, Wichita, Pittsburgh, Hutchinson and Newton Kan.; Omaha, Nebraska; Council Bluffs, Ia., and Fort Worth, Waco, Galveston and El Paso, Tex. The total population served is in excess of 1,425,000. The annual gross earnings of all American Power & Light Company properties aggregate approximately $13,100,000 and the annual net earnings approximately $5,200,000.

American Gas & Electric Company controls companies operating electric light and power systems in 107 communities having an aggregate population of 925,000. Among the cities served are Scranton, Pa.; Atlantic City, N. J.; Marion and Muncie, Ind.; Rockford, Ill.; Wheeling, W. Va.; and Canton, Mount Vernon, Fremont, Fostoria, Tiffin and Newark, Ohio. The annual gross earnings of all American Gas & Electric Company subsidiaries aggregate approximately $9,200,000 and the annual net earnings approximately $2,750,000.

Utah Securities Corporation controls the Utah Power & Light Company, which company, either directly or through subsidiary companies, supplies electric light and power service in an extensive territory in Utah, southeastern Idaho and southwestern Colorado. More than 100 communities are thus served, among the most important cities being Salt Lake City, Ogden, Provo and Logan, Utah; Idaho Falls, Rexburg, Preston and Montpelier, Idaho; and Durango, Telluride, Montrose and Delta, Colo. Street railway service is also supplied in Salt Lake City and gas service in Ogden. Annual gross earnings of all the Utah Securities Corporation properties aggregate approximately $7,000,000 and net earnings approximately $3,750,000.

Lehigh Power Securities Corporation owns all the stock of the Lehigh Navigation Electric Company (and through such ownership controls The Harwood Electric Company and other subsidiaries), a substantial majority of both classes of stock of the Lehigh Valley Transit Company (and through such ownership controls the Lehigh Valley Light & Power Company) and all the stocks of companies formerly controlled by the Northern Central Company. The operating Companies supply a total of 90 communities with electric light and power, gas and, or street and interurban railway service. Among the communities served are Bethlehem, Allentown, Williamsport, Easton, Norristown, Shenandoah and Mahony City, Pa., Hagerstown, Md., and Phillipsburg, N. J. The total population served is estimated at 600,000. Approximately 59,500 customers are supplied with electric light and power or gas service. Annual gross earnings of the properties are about $8,100,000 and net earnings about $2,640,000.

Carolina Power & Light Company operates electric light and power systems in Raleigh, N. C., and fifteen other communities, the street railway and gas systems in Raleigh and the gas system in Durham, N. C. In addition to operating these properties, the Carolina Power & Light Company controls, through ownership of all their common stock, except directors' shares, the Yadkin River Power Company, which owns and operates a hydro-electric development with an initial installed capacity of 32,000 horsepower and an extensive system of high-tension transmission and distributing lines, and the Asheville Power & Light Company, which operates the electric light, street railway and gas services in Asheville, N. C. The Yadkin River Power Company, in turn owns all the stock, except directors' shares, of the Carolina Gas &

Electric Company, operating electric light and power systems in six cities. The annual gross earnings of all properties operated and controlled by the Carolina Power & Light Company are in excess of $2,000,000 and the net earnings are in excess of $918,000.

National Securities Corporation controls the Idaho Power Company, which supplies electric light and power service to a large part of the state of Idaho. Idaho Power Company controls the Boise Valley Traction Company. About 22,800 customers are supplied with electric light and power service. Annual gross earnings of the properties aggregate approximately $1,800,000 and net earnings approximately $825,000.

The properties of the American Power & Light Company, American Gas & Electric Company, Utah Securities Corporation, Lehigh Power Securities Corporation, Carolina Power & Light Company and National Securities Corporation are located in nineteen states. A total of 573 communities are served by the operating companies. The aggregate number of customers is approximately 535,000. The companies have aggregate gross earnings of approximately $41,200,000 and aggregate net earnings of approximately $16,100,000.

The earnings of the operating properties have grown rapidly, due to the Electric Bond and Share Company's policy of constructing the most modern high efficiency plants with the purpose in view of providing the largest and best service to the public at the lowest rates consistent with the most satisfactory service.

CHARLES L. EIDLITZ

Looking through a copy of "Notable New Yorkers," issued in the late 90's, one is confronted by the features of not a few

CHARLES L. EIDLITZ

of the public men, leaders in the arts, sciences and industries, who are still among the familiar personalities. A sight of them in youthful guise gives a curious sensation of the transitory nature of mundane things and emphasizes the interest attached to recording within the covers of a book what might not otherwise be preserved. In this family album of Father Knickerbocker appears Charles L. Eidlitz. We do not mean to suggest that Mr. Eidlitz is to be identified only with a bygone day, but that now as then he is one of the representative figures of his profession in the metropolis. It remains to briefly chronicle a few biographical facts. Mr. Eidlitz began being a New Yorker at birth, or September 3, 1866. He is the son of the late Marc Eidlitz, well known in New York construction circles. Things electrical were his penchant from the very first. As a boy he was one of the numerous youthful apprentices at the old Edison Machine Works on Goerck Street, New York City. "Testing boys" they were called, being used in the testing room. About two years after graduation from Columbia University in the Class of 1888, Mr. Eidlitz had formed his plan for an independent business, organizing Charles L. Eidlitz Company, electrical contractors. The firm's affairs progressed successfully for more than twenty years, or until, as president,

WILLIAM B. ELLIOTT

Mr. Eidlitz retired in 1913, bringing its operations to a close. Though nominally in retirement from active business, he is actually a very busy man at the present day. He is president of the Metropolitan Electric Manufacturing Company, which he organized in 1902, president of the Atlantic Electric Goods Company of recent inception, and interested less directly in several other enterprises. Mr. Eidlitz's influence has been strongly felt in the counsels of his associates, the electrical contracting profession at large, to which he has brought marked organizing and executive ability. Of the fruits of this participation in activities of extended scope, it is to be recalled that he founded the National Electrical Contractors Association, serving as its first president from 1901 to 1903, and established the Building Trades Employers' Association of New York City in 1903, and of which he was president until 1905. Mr. Eidlitz is a member of the New York Electrical Society, the Building Trades' Club and a founder member of Edison Pioneers; in post-collegiate intercourse, of the Columbia University and Delta Upsilon clubs; also the Briarcliff Golf Club. Mr. Eidlitz's offices are at 1170 Broadway, and his residence at 270 Park Avenue, New York City.

WILLIAM BREWSTER ELLIOTT

The record of accomplishment made by William Brewster Elliott has evidenced those qualities of constructive ambition combined with self reliance which are associated in the public mind with the upbuilding of our great industries. In his own sphere he began at an early age to seek out opportunity. By dint of labor and the merit of his ideas he has achieved a position recognized as well won. Mr. Elliott's native town, Montgomery, Orange County, New York, where he was born December 22, 1866, gave him an academic schooling, but for broader education he went to the metropolis. In New York he started at the bottom of the ladder, learning the trade of machinist as an apprentice with the National Machine Company, at 151 West 29th Street, and taking special courses at Cooper Union. No greater self satisfaction is to be had perhaps than that enjoyed by the fortunate individuals who have the passion for making things, for handling tools and watching the growth of their own handiwork. It had been Mr. Elliott's boyhood delight and it became fruitful of invention in after years when he turned his attention to the intricacies of motor construction. Aided by his friend, J. W. Eskholm, he perfected and patented, in 1894, a novel motor having a stationary armature and revolving field. The design of the machine, which was built so that the brushes ran on the inside of the commutator, overcame the imperfections of similar but less developed types of motors. Mr. Elliott was the co-inventor with Mr. Eskholm of a system for controlling the speed of electric motors used in operating printing presses. Further, and in a like exercise of his talent, he originated the so called C. & C. system of control, by means of which the electrical operation of newspaper printing presses was much accelerated and improved. The worth of the system may be judged by the fact that it made possible a speed range of over twenty to one, attained without armature resistance or any mechanical appliances such as gear changes. When electric welding by the arc method was first broached, Mr. Elliott was among those whose interest was strongly attracted, so much so that he has devoted considerable effort to encouraging the commercial adaptation of the process and to advocating the use of the constant current dynamo for its purpose. Upon his entrance into the electrical profession Mr. Elliott was favored by the friendship of Harvey Lamb Lufkin, who, as general sales agent of the C. & C. Electric Motor Company, was instrumental in his being offered and accepting the position of installing engineer with that company. His hopes were brightened by the fine future predicted for the industry and the encouragement of Mr. Lufkin. Mr. Lemuel E. Serrell was his immediate

superior, and their plant at the time was in the Marvin Safe Company's factory on South Fifth Avenue, near Bleecker Street, New York. Mr. Elliott remained with the company through its reorganization into the C. & C. Electric Company, at which time they moved to a new plant at 402 and 404 Greenwich Street, New York City. This new plant, at 402 Greenwich Street, was remarkable for being the first to be so constructed as to house the power plant in the basement, and also for being equipped with independent motors operating the individual machines on different floors. The plan was the conception of H. L. Lufkin, who had the practicability of his ideas successfully demonstrated. When the plant was again moved, this time to Garwood, New Jersey, Mr. Elliott became works manager. Stated in chronological sequence, Mr. Elliott's engagements in the industry were: machinist with the National Machine Co.; machinist with the Manhattan Railroad Co.; foreman and installation engineer of the C. & C. Electric Motor Co.; works manager and general manager of the C. & C. Electric Co.; president of the Garwood Electric Co.; and finally, his present position as partner in the prominent firm of W. B. Elliott & Sons and as manager of the C. & C. Electric & Manufacturing Co. He was one of the charter members of the National Isolated Power Plant Association and its treasurer for the first year. Mr. Elliott has offices at 114 Liberty Street, New York. His home is at 256 Dudley Avenue, Westfield, New Jersey.

FORD, BACON & DAVIS

The firm of Ford, Bacon & Davis, which is one of the foremost in the United States in engineering work and in public utility finance, was established in Philadelphia in 1894 by Messrs. Frank R. Ford and George W. Bacon. In 1895, Mr. George H. Davis was admitted to partnership, and in 1912 the firm was further enlarged by the admission of Mr. Charles F. Uebelacker, Col. Charles N. Black and Mr. William von Phul.

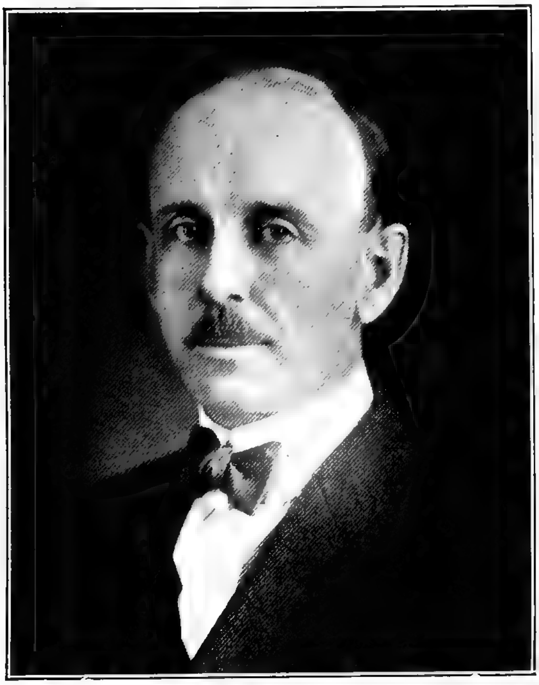
This firm has specialized in public utility engineering, but it has covered a broad field not only in professional work but in the superintendence of important construction of industrial, hydraulic and irrigation projects. This work of construction superintendence has so developed that within the past year the Ford, Bacon & Davis Corporation has been organized to handle general engineering construction under contract. The engineering offices of the firm, in addition to consultation and design, handle valuations, reports and management of public utilities and of industrial enterprises which present engineering problems.

Frank R. Ford was graduated from the University of Pennsylvania with the degree of B.S. in 1890, and with the degree of M.E. in 1891. Previous to the organization of the firm he was connected with several electric manufacturing concerns, including the Short Electric Railway Co. of Cleveland. In 1896-1897 he represented the American Electric Railway Association at the National Conference of Standard Electrical Rules, which formulated the original National Electrical Code. He has been a member of the American Electric Railway Association's Committee on Federal Relations since 1908 and has also served as Chairman of its Committee on Rates and Fares, which submitted a noteworthy report in 1911. In July, 1917, Mr. Ford was appointed by Governor Edge of New Jersey as a member of the New York, New Jersey Port & Harbor Development Commission, which is making a comprehensive study and plan of development of the Port of New York. Mr. Ford has contributed many articles to technical journals, including the Electric Railway Journal and Annals of American Academy of Political and Social Science. He is a member of the American Institute of Electrical Engineers and of the University, Railroad and Downtown Clubs of New York City.

George W. Bacon was graduated from Cornell University with the degree of M.E. in 1892. Subsequently he was employed by electrical, manufacturing and engineering companies until 1894, when he organ-

PAUL McJUNKIN

Tungsten and molybdenum, that duo of related elements embodied in our high-powered incandescent lighting, have been the subject of the most absorbing study and investigation on the part of Paul McJunkin. In the course of a practice as consulting engineer, begun in 1903, he has concentrated effort upon the development



PAUL McJUNKIN

of equipment and processes for the manufacture of incandescent electric lamps. His office and laboratory are situated at 15 East Fortieth Street, New York City.

Mr. McJunkin is much more than a seeker after commercial success. He is a scientist for science's sake, has followed and participated in each step of growth in his especial branch of investigation. At Vienna, Austria, in March, 1906, Mr. McJunkin was one of the first few persons to witness the illumination of electric lamps with pure tungsten filaments as they burned in the laboratory of Johann Kremenezky. The filaments of these lamps were made by Dr. Hans Kuzel with his colloidal process, a method of manufacture which guaranteed extreme purity in that the tungsten was precipitated from solution in the highest state of chemical purity possible, and the very finely divided metallic tungsten, with only colloidal tungsten as a binder, pressed into threads, dried and then, by the passage of an electric current, sintered into a homogeneous tungsten filament. That same year (April, 1906) Mr. McJunkin brought three of Dr. Kuzel's lamps to America. They were the object of great interest to all electrical men privileged to view them, and, so far as ascertainable, were the first pure tungsten filament lamps to be seen here.

Mr. McJunkin has a firm faith in the increasing value of tungsten. Acknowledgment and prediction are mingled in his following words: "The commercial production of pure tungsten and molybdenum, compelled by their value as an incandescent lamp filament, has resulted in a very great advance in X-Ray work, thanks to Dr. Coolidge; in a great improvement in phonograph needles, first suggested by Mr. C. H. Humphries; in the replacement of an immense quantity of platinum in electric contacts; has made possible several important pieces of wireless telegraph apparatus, and these metals are destined to play an increasingly important rôle in many of the arts and industries." In a technical booklet describing the properties of tungsten, he cites other diversified applications, including its use for aeroplane cables, wire and ribbon in the heating coils of electric furnaces, the hastening of chemical reactions ordinarily dependent upon sunlight, strings for pianos, etc., *ad infinitum*.

Mr. McJunkin was originally from Iowa, having been born at Sigourney August 2, 1875. He is a graduate of the Massachusetts Institute of Technology, class of 1898, and later pursued post-graduate work in physics and chemistry at the universities of Chicago and Johns Hopkins. His first industrial employment was had in 1899 as supervisor of technical work with the Sawyer-Man Electric Company of Alleghany, Pa. Mr. McJunkin is a member of the Engineers, Chemists and Technology clubs of New York, the Engineers' Club of Boston, the American Institute of Electrical Engineers and the American Chemical Society.

THOMAS FRANCIS MULLANEY

Thomas F. Mullaney, Chief Engineer of the Third Avenue Railroad, New York, who is an expert on the installation and operation of electric surface lines, was born in Ireland, March 3, 1867. He was brought to this country by his parents when one year old and received his education in the common schools of New Braintree and Oakham, Mass. He was apprentice to the firm of McMahon & Carver, tool makers of Worcester, when fifteen years of age, and later while installing machinery in the Thomson-Houston Lynn works, became imbued with a desire for electrical work. He thereupon took up the student course with that company, with whom he remained until after absorption by the General Electric, his term of service with the two concerns being twenty years, during which period he installed or did work for about 100 electric railways and power plants from Bangor to the Pacific coast, among them being the first installations in Boston, Philadelphia, Cleveland, St. Louis, the Chicago Elevated, New York Elevated and the New York Central R. R. He also constructed the Lenox Avenue Railroad, the first underground electric trolley built in New York City. In 1908 Mr. Mullaney was appointed Chief Engineer of the Third Avenue Railroad, a position he still retains. He is the inventor of many devices now in use, and is a member of the Engineers' Club and the Scarsdale Golf and Country Club.

CHAPTER XV

DEVELOPMENT OF HYDRO-ELECTRIC POWER

THE practical application of the idea of power development through the revolution of a wheel impelled by the impact of a jet of water upon it had its inception back four centuries or more in Western Europe. In America the use of water wheels for the development of power for mills of various kinds dates from the earliest years of Anglo-Saxon colonization. The early wheels were of various types previously used in Europe, construction and application being modified to suit the conditions.

No improvements made in America were patented until 1853, when a patent for an impulse wheel for hydraulic power development was granted to an inventor named Atkins. Miners in California had, however, from the time of the gold rush in 1849 made for their own use impulse wheels which they used to drive their mills, several new ideas appearing from time to time until 1860, and later. The ordinary form of wheel, as made by these Californians used flat blocks as buckets. The pioneers of the Golden West found the water powers of the Sierras a great aid to their labors, and were taught by experience and necessity to use them with much success.

By later inventors improvements were made by which a larger percentage of the power capacity of the stream utilized was rendered available for power applications. As a result of investigations and tests made by L. A. Pelton and his associates prior to 1880 a form of bucket with a dividing wedge, known as the Pelton bucket, was evolved, and the impulse wheel known as the Pelton became a standard in its class and entered into general use. Applications of this wheel have been made in various hydro-mechanical ways, but in 1890 the Electrical Period of water power development in America began with two 150 kw. single-phase generators which were installed by the Telluride Power Company, at Ames, Colorado. These generators were operated by Pelton wheels under a 500-ft. head. Another early development, installed in 1891, was at Virginia City, Nevada. The town, which is situated on a mountainside, is noted as the locality where the deepest productive mines of the famous "Bonanza" group of the Comstock lode are located. The mines, driven to low levels to add to the great fortunes of their millionaire owners, experienced water troubles which made further mining in these workings dangerous and costly, the heat and bad air, added to the dampness, making the conditions worse. Arrangements were made with Adolph Sutro to drive a tunnel through the mountain 20,500 feet to drain and ventilate the Comstock mines, and incidentally to tap new veins, at a level of about 1,700 feet below the general surface. It was completed at a cost of $6,500,000. To provide more power for the mill a generating

plant was installed in the Chollar shaft consisting of six 40-inch Pelton wheels driven by water under 1,680 feet head, operating six 100-horsepower, constant current Brush dynamos, running at a speed of 900 r.p.m. The line was carried up the shaft to the mill, about one mile distant.

Among the earliest plants (single-phase) to transmit power to any important distance was one installed in 1889 between Oregon City and Portland, Oregon, a distance of 13 miles, the generator being operated by turbines; another installed in 1891 at Pomona, California, the generators of which were driven by impulse wheels, and the current transmitted to San Bernardino, California, 28¾ miles, at 10,000 volts pressure; another at Telluride, Colorado, 1891, with a transmission of 15 miles; and one at Bodie, California, which went into operation in 1893, with a 120 kw. single-phase generator driven by an impulse-wheel under 350-feet head, the current being transmitted 12½ miles at 3,500 volts pressure.

A great advance was marked in the installation of the three-phase experimental transmission line from Lauffen, Germany, 105 miles to Frankfort, built in 1891. Simultaneously two plants (three-phase) were under construction in America, one in California from Mill Creek to Redlands, 7.5 miles, and one at Guadalajara, Mexico, with 18 miles transmission. Similar plants were, about the same time, being installed in Italy and Sweden.

These early plants established the practicability and value of the hydro-electric plant for long-distance transmission, and problems of engineering improvement for plants of that kind have since enlisted the interested attention of many experts in hydraulic and electrical machinery. For convenience plants are divided into two types; first, the low-head plant, with heads up to 200 feet, in which the water is taken directly from the stream in short penstocks and used in large quantities, requiring the turbine as a water-motor. The second division includes the medium head (with heads from 200 to 750 feet), and high head plants, including all above 750 feet, and using as water motor either the impulse wheel or the turbine. "Head" in this connection, means the vertical height of the column of water above the water-wheel. The range of head determines, at the two extremes, the type of water motor. For units under low head and even of moderate size, 1,000 kw. or under, the turbine is practically the only motor which can be used. For high heads, above 1,000 feet, the impulse wheel is the only motor that is ordinarily used. Between the two extremes both types of wheels are available, with a tendency to use turbines on higher and higher heads as the size of units grows larger. The design of American turbines has made rapid progress toward perfection, efficiencies exceeding 93 per cent having been revealed in various tests.

The size of hydro-electric units has steadily increased. The 3,750 kw. units at Niagara Falls were the largest until 1904, at which date there were numerous water-wheel driven units of 2,000 kw. in the West. The 7,500 kw. unit of the Canadian Niagara Falls plant was placed in operation in 1905. The 5,000 kw. unit at de Sabla, California, 1904, remained a standard in the West until in 1908 the 10,000 kw. units at Las Plumas, California, were put in operation. Numerous units of 12,000 to 13,500 kw. are now at work, and there are units of 17,500 kw. at Big Creek, California. No limit seems to have been reached. A unit of 25,000 kw., with a single runner turbine of 36,000 h.p., was projected in 1913, and manufacturers were ready to build it; and the possibilities of hydro-electric design are illustrated by the actual building of a steam-unit turbine of 35,000 kw. capacity.

The size of power plants has increased at a pace corresponding with that of the sizes of hydro-electric units. From the pioneer plants of 200 to 300 kw. capacity development has brought a condition where plants of 50,000 kw. capacity are common, and the highest American development includes such plants as that at Keokuk, Iowa, with 112,500-kw. installed capacity; that at Cedar Rapids, with 90,000-kw. installed capacity, and the

great Niagara plants on both sides of the National boundary.

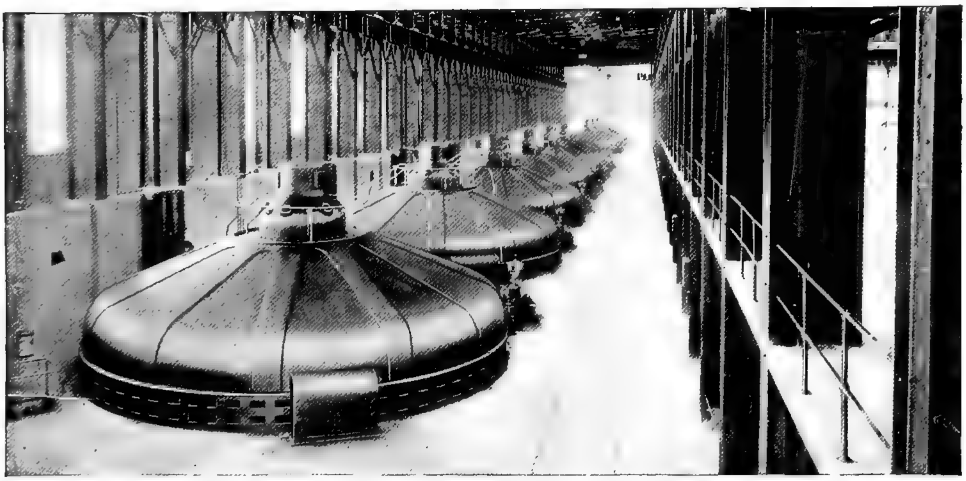
The United States industrial census divides its statistical work concerning the industries and resources of the Nation into five-year periods, and its statistics of those industries that can be classed as "public utilities" are based on their condition and products in the calendar years ending in "2" and "7"; while similar returns concerning manufactures are based on their condition in the years ending in "4" and "9." In these two subdivisions of census results the figures at this writing available are those of 1909 for "manufactures" and "mines and quarries," and of 1912 for "public utilities." The figures, being for different periods, are not quite parallel in application, but are to a certain degree relevant. Thus the Census Bureau gives the total fixed installed primary power, as expressed in horsepower.

Commercial and municipal central electric stations, 1912	7,528,645 h.p.
Street and electric railways, 1912	3,665,051 "
Steam road electrification, 1912	193,956 "
	11,387,655 h.p.
Manufacturing, 1909	16,802,706 "
Mines and quarries, 1909	4,402,554 "
Total fixed installed primary power	32,592,915 h.p.

Of this total the following is water-power:

Commercial and municipal central electric stations, 1912	2,417,081 h.p.
Street and electric railways, 1912	471,307 "
Steam road electrification, 1912	8,000 "
	2,950,388 h.p.
Manufacturing, 1909	1,822,885 "
Mines and quarries, 1909	97,460 "
Total installed water power	4,870,736 h.p.

Charles W. Comstock, in a valuable paper presented before the December, 1916, meeting of the American Institute of Electrical Engineers on "The Future of Water Power in the United States," gives an estimate of the equivalent in fixed power of the power generated by the steam locomotives in service in this country, which he established as being in round numbers, 65,000 locomotives for the fiscal year ended June 30, 1914. Premising that it would be absolutely meaningless, if even the data were obtainable, to add together the rated horsepower of these locomotives as a workable total, Mr. Comstock proceeds by indirect method on the basis of fuel consumed by these locomotives, the cost of which aggregated $242,000,000 in that year. While this included a small proportion of fuel oil, an overwhelmingly large part of this fuel was soft coal. He,



Power House of the Cedars Rapids Manufacturing and Power Company

therefore, assuming $2 per ton as the average price that year, and allowing 26 tons per h.p. year (about 6 pounds per h.p. hour) the equivalent continuous output is estimated at 4,692,000 h.p., or, with a 60 per cent load factor, 7,820,000 h.p., which equivalent of fixed installed horsepower, added to the census estimates of 32,592,915 h.p., would make a grand total of 40,392,915 h.p. for the entire installed primary power of the country, including locomotives. Of that total the installed water power equals 12 per cent.

Water supply paper No. 234 of the United States Geological Survey, by M. O. Leighton, makes an estimate of the water power resources of the United States, and states the absolute minimum of total water power of the United States as 36,916,250 h.p. (based on the stream discharge "for the lowest two consecutive seven-day periods in each year") and an assumed maximum as 66,518,500 h.p., being the quantity which could be generated during six months in the year. Neither of these estimates takes account of storage, which Mr. Leighton estimates would, by the use of all practicable storage sites, bring the grand total of all possible water power development up to 200,000,000 h.p.

The Commissioner of Corporations in 1912 revised the Leighton estimate in a statement of the potential water-power development. One change was the revision of the figures for Niagara, which Mr. Leighton gave as 5,800,000 h.p. minimum and 6,500,000 assumed maximum. As under the present treaty only 25 per cent of the possible power at Niagara Falls can be developed, and of this the United States is entitled to only 36 per cent, the Commissioner corrected these figures accordingly. Other revisions of detail were made for various reasons. The Commissioner's statement took no account of any increase of development to be obtained by storage, which he regarded as "mainly theoretical." Without reference to the additions which storage of water may make available, the Commission arrives at the following figures, stated by groups of States:

States	*Minimum horsepower*	*Assumed maximum horsepower*
North Atlantic	2,225,000	4,092,000
South Atlantic	2,344,000	4,256,000
North Central	1,733,000	3,558,000
South Central	1,438,000	2,785,000
Western	18,996,000	36,707,000
	26,736,000	51,398,000

This same report of the Commissioner of Corporations arrives at a total of 4,760,000 h.p. for the installed water power in the United States, arranged by the same regional groups, as follows:

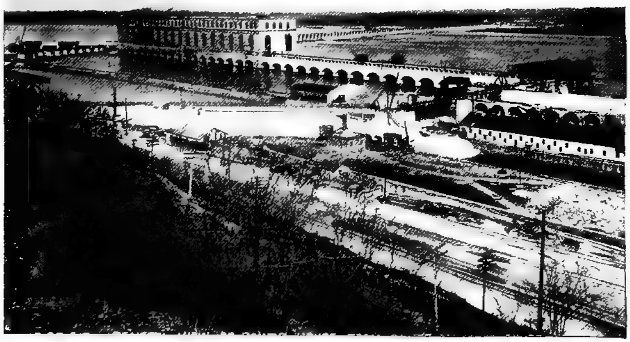
North Atlantic	2,134,000
South Atlantic	589,000
North Central	729,000
South Central	79,000
Western	1,229,000
	4,760,000

By this estimate it appears that the North Atlantic States had already nearly exhausted their water-power resources as expressed in the minimum total above, but the figures are six years old and considerable additions to the volume of installed water power have in the intervening period been made in the North Atlantic States, so that the total of installed water power has already passed the minimum estimated. The omission of any calculation for water power developed from stored waters leaves out an important equation of the water power problem as it has been developed in recent years, for engineers of special competence in the field for hydraulics count upon large increase of water power by the construction of dams and reservoirs to store waters for industrial as well as for irrigation purposes.

Heretofore the developed water powers have been chiefly applied for the purposes of generation and distribution of electric current for light, mechanical power, and, to a certain extent, for heating purposes. Except at Niagara Falls a very small portion of this power development has been for electro-chemical or electro-metallurgical industries. Wonderful results have been achieved in these branches at Niagara and in Europe; the applications of electro-

chemistry and electro-metallurgy through the generation of heavy currents by water power have been very great, but in the United States initiative in these branches has been very slow, until recently accelerated by war needs.

Water-power developments for light, heat and power distribution have only been possible on a large and lucrative scale in locations which are within reach by present transmission methods from large centers of population and industry. Niagara Falls developments had Buffalo and other near-by cities as a distributive area, using the current for lighting and for railway propulsion, although the power was also applied locally in building up large electro-chemical and electro-metallurgical plants, in Niagara's case. Industrial conditions in the Southern States have given rise to the hydro-electric power system of the Southern Power Company, bringing under one control over 100,000 h.p. Very nearly one half of the cotton mills of the South which depend upon outside sources of motive power, and they number 75% of the South's total, are supplied by this company. Production of fertilizer and electro-metallurgical processes are progressing under its protective and fostering influence. The Alabama Power Company, with its one thousand odd miles of transmission, is a great feature of progress in the South and has allied its forces to the manufacturing of high-grade steel. The Colorado Power Company, utilizing the water power resources of the Rocky Mountain region, and located in the midst of mines and towns hungry for power, stands on the threshold of great possibilities for growth. But the other great water-power developments have been practically confined to the satisfaction of urban and intra-urban requirements for light, transportation, heating and the power needs of ordinary city industries. The important plants of the Pacific Gas and Electric Company and its subsidiaries reach fine markets around San Francisco Bay. The Mississippi River Power Co. had a contract for the delivery of 60,000 h.p. to St. Louis before completing the development of its great plant at Keokuk. The McCall Ferry water-power development is within seventy miles of Philadelphia and supplies Baltimore, 40 miles away; and the cities of Seattle, Tacoma and the entire Puget Sound district lie within the direct range of the hydro-electric development at Snoqualmie Falls and kindred plants.



General View of Power House of the Mississippi River Power Company of Keokuk, Iowa, taken from the Iowa Side

According to the statistics already quoted, assuming the lowest estimate of the minimum potential water-power development possibilities and the highest estimate for installed water powers, less than

twenty per cent has been developed without taking into account any possible increase of development to be obtained by storage. In the western region where 70 per cent of the potential water power is located, there has only been a development of 6 per cent. The undeveloped water power resources of that region have no large aggregation of people or industries near them to justify large-scale development for the supplying of light, heat or the power needs of transportation lines or ordinary industries. How, then, can these great sources of reserved energy be profitably utilized?

Without speculating upon the probability of progressive development of methods of electrical transmission of power which will greatly lengthen the distance that can be covered effectively and economically, so that communities much more distant than now reachable may be served, many suggestions from foreign practice and experience may be studied to advantage. The French Alps are remote from large urban populations and the water power developments of that region are actually large and potentially larger. Most of this hydro-electric power is turned to the prosecution of electro-metallurgical processes, chiefly in the manufacture of special alloys; and there are in that section numerous large plants producing ferro - titanium, ferro - tungsten, ferro - molybdenum, and other alloys upon a large scale, one of the operating plants (the Paul Girod Works) itself producing more than two million dollars worth of these alloys every year. It is notably true that the part of our own Great West where there are the greatest number of undeveloped water powers is also precisely the region of the country where raw materials for such metallurgical use are the most profusely distributed.

The three Pacific Coast States alone contain approximately 45 per cent of the potential water power of the country. Their aggregate present development is about 900,000 h.p., leaving possibilities from a minimum of 10,500,000 h.p. to an assumed maximum of 22,300,000 h.p. available for development, without considering the storage factor.

Compare this again with the French Alps development as summarized in Mr. Comstock's paper, before referred to, and quoted by him from the statistics of 1910. There was an aggregate of 475,000 h.p. installed, 80,000 h.p. additional under construction, and 700,000 h.p. projected. Of the power produced 210,000 h.p. was consumed in electro-metallurgical work, 60,000 h.p. in electro-chemical work, 30,000 h.p. in the chemical and wood industries and 165,000 h.p. for commercial power, light and traction.

Compare, furthermore, the Norwegian Nitrate Company, which, in 1913, had 260,000 h.p. already in operation, used solely for the process of fixation of atmospheric nitrogen, and had planned to develop 280,000 additional horsepower for the same electro-chemical purpose. The furnace and process used by the company were not invented until 1903. Mr. Comstock called attention to the fact that although fixation of atmospheric nitrogen has been claimed to be impractical in the United States, that St. Louis, which receives power from the Keokuk plant at $24 per k.w.-year could at that rate produce at a power cost of about $44 a ton of nitric acid, the selling price of which was about $95 per ton.

But it is not necessary to use power transmitted 140 miles to produce nitric acid by the fixation of atmospheric nitrogen. The industry demands cheap power in great quantity, but it is an industry which is capable of indefinite expansion, because the demand for the product continues to grow. The Secretary of Agriculture in his annual report for 1914 called attention to significant facts. The population of the United States had increased 23,000,000 in fifteen years, but the strictly rural districts had shown an increase of barely 6,000,000. More mouths to feed and fewer husbandmen is the most serious problem of the age. The reports of animal industry show an actual decline in numbers of meat animals in the decade from 1899 to 1909 in spite of an increase in population during the same period of more than 16,000,000 people, cattle decreasing from 50,000,000 to 41,000,000 sheep from 61,000,000 to 52,000,000, and hogs from 63,000,000 to 55,000,000.

The acreage of cereals harvested increased from 185,000,000 acres to only 191,000,000 acres or 3.5 per cent, while the population increased 22.4 per cent during the decade. While there are 935,000,000 acres of arable land in the country, only 400,000,000 or 43 per cent were under cultivation. Man-power is needed, but even more vital (because mechanical improvements take the place of man-power very largely) is the need of a constant replenishment of the soil. The war has disarranged our access to supplies of fertilizers, and one of the most important of these is nitric acid. For our supply we depend chiefly on Chile, which would be a menace in case of war and means the payment of export duties and profits amounting to about $5,000,000 annually in time of peace. The production of many of our most highly nitrogenous food products has been steadily declining, and American farmers have been producing less per acre than have European producers. Allerton S. Cushman, speaking on "Water-Power Development and the Food Problem," on April 26, 1916, before the American Institute of Electrical Engineers, said in regard to this problem:

"The food supply depends, in the last analysis, upon the plant food supply. The production of nitrogen, which is one of the three principal fertilizer ingredients, is distinctly a water-power proposition, involving the fixation of atmospheric nitrogen. More than 80 per cent of mixed fertilizer produced in the United States is used east of the Allegheny Mountains, and for the fertilizer problem the water power must be developed in those parts of the country where the demand for intensive agriculture exists. A feasible and proper plan for a water-power development in this country will have a profound influence in the development and distribution of cheap fertilizer ingredients which are so necessary under modern intensive conditions in the growth of population and its relation to agriculture."

Hydro-Electric Station and Development. Little Falls Washington Water Power Company, Spokane, Wash.

We have seen in various instances the prompt and efficient way in which the American manufacturer can rally to the

solution of any emergency problem. The war has presented many instances. The thought that we should be forced into a great war which would shut us off from supplies of many necessary things had never occurred to Americans. In some lines, particularly many chemicals, this country had permitted itself to become wholly dependent upon Germany. But when it was found that the dyestuffs and chemicals which had been almost exclusively imported from Germany would be unobtainable otherwise, it did not take American industry long to find a way to establish their production as a home industry. The electro-chemical industries are beginning, for similar reasons, to bulk largely in the industrial thought of the United States, and for their enlargement and great improvement there is a need of cheap and plentiful power; a need which can only be satisfied through hydro-electric equipment.

Hydro-electric plants upon a large scale are expensive to equip, and can only be made to pay when harnessed to industries which are in constant need of large supplies of power, in which case hydro-electric power is almost ideal for large scale production such as is needed in the manufacture of atmospheric nitrogen and in other electro-chemical and electro-metallurgical industries. The first hydro-electric plant in the United States for the manufacture of nitrates was ordered by the Government on February 25, 1918. It was built at Muscle Shoals on the Tennessee River in Alabama on an appropriate power site. The plant, now that the war is ended, will be used for the manufacture of fertilizing material. Our domestic supply is insufficient and it is quite necessary that we engage in large scale production for our own needs.

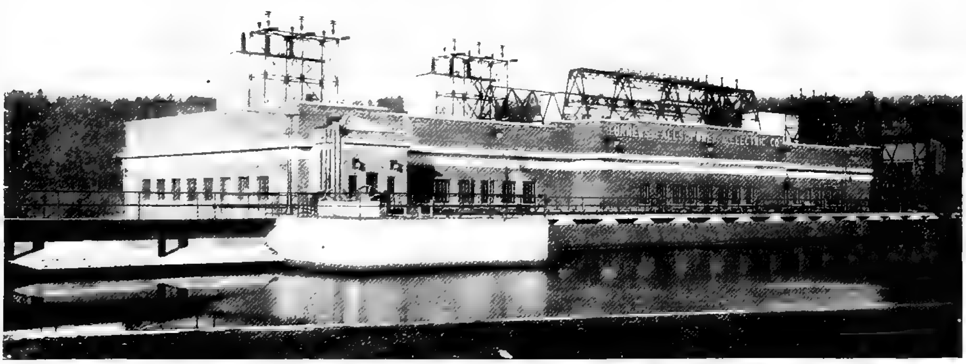
Almost equally pressing as our actual war need is that of agriculture for nitrogen for fertilizing. Europe has 1,200,000 h.p. developed by hydro-electric energy for the purpose of fertilization of the land, by production of atmospheric nitrogen by the fixation process. This is a process which can be carried on upon a large scale with ample supplies of accessible water power. But there are available means of securing a supply of nitrogen upon a large scale by other means than extraction from the air. The State of Idaho has a large amount of water power available and accessible for the nitrate industry. As those regions are for the greater part remote from coal supply, power derived from steam is very expensive, but in the same region the potentialities of water power are greater and more accessible than in any other region of the country. Much of this water power is under Government ownership and by recent decision is legally reserved from location and private ownership, but the tendency is toward a liberal policy of fostering industrial use of the power under lease, and now that the litigated questions have been decided and those who need the power know what to do and the terms involved, the outlook is for a large increase in Western hydraulic power development in connection with the new alignments of industry by which many of the electro-chemical and electro-metallurgical products formerly supplied to this country from foreign factories will be naturalized in this country. Raw material for the nitrate industry is available in billions of tons of phosphorous rock from which nitric acid can be extracted in large quantities by electrical process. This and many industries like it form the most complete answer to the most frequent objections to the use of far-western water powers because of their remoteness from the large cities of the East and Middle West. As Norway and Chile have been our chief sources of supply it can hardly be contended that Idaho is too remote for the production of nitrates.

The Food Administration, after we entered the World War, kept up an incessant reminder of the duty devolving upon citizens not only to conserve the food supplies but also to increase production. Increased acreage is desirable to that end, but an even more important factor to increased production in emergency is to make production in the areas already under cultivation more intensive. But to do this in the present situation with the existing shortage of farm labor is not an easy task. It may be accomplished to a considerable degree if the soil is enriched by generous fertilization. The average crop of wheat in this country is fifteen

bushels per acre as against a European average of thirty-two bushels per acre, while that continent produces 47 bushels of oats to our 29 bushels. This is partly due to closer attention to more complete pulverization and better care of the cultivation of the crop, but the chief factor is found in the fact that we use only 28 pounds of fertilizer to the acre on an average, while the European farmer uses 200 pounds per acre per annum. There can be no doubt that with intensive farming equal to that of the European farmer (which with our superior farming machinery could be done with less man power here than there), and an equal use of fertilizers, there could be obtained an acreage percentage production equal to that of Europe. If such a production were available the grain problem which proved so serious would have been easily solved. Approach to such efficiency is not possible except by multiplying our fertilizer resources to a degree only possible by the generation of greatly increased resources in hydro-electric energy.

Another great use that can be made of the unused water powers is in a greatly increased use of the mountain waters for irrigation. As to the value of irrigation to the arid areas of the West there is no necessity to argue. Deserts that have been made to bloom and produce give eloquent testimony of the practical value of adding moisture to arid areas. But irrigation measures which depend upon gravity flow alone for water distribution leave unirrigated many valuable areas which by developing water powers may be fed with needed water by means of pumps operated by hydro-electric power.

In the greater development of water power the larger success of our manufactures and the greater prosperity of those who labor are intimately bound up. A recent comparison in an English industrial report illustrates in these words: "The only way to increase prosperity is to increase the net output per head of the workers employed. It is possible to increase the output per head by harder work on the part of each individual, but there is far greater promise in increasing his output by giving him more machinery to multiply the effectiveness of his efforts. In the United States the amount of power used per worker is 56 per cent more than in the United Kingdom. On the other hand, not only are the standard rates of wages higher in the United States, but living conditions are better. The best cure for low wages is more motive power. Or from the manufacturer's point of view the only offset against the increasing cost of labor is the more extensive use of water power. Thus the solution of the workman's problem, also that of his employer, is the same, namely, the greatest possible use of power."



Montague City Station of Turner's Falls Power and Electric Company

Another important feature in the greater development of hydraulic power is the saving of fuel resulting from the development

of hydro-electric power. A recent estimate by Mr. E. W. Rice, Jr., was that the electrification of the railroads of the country would save a million tons of coal annually or about two-thirds of the coal used by locomotives, would permit a speeding up of train schedules of 25 per cent, would eliminate the haulage of coal to the extent of increasing trackage capacity 10 per cent, and otherwise be beneficial in many social and industrial ways. It is not within the range of possibility that hydro-electric power will displace steam horsepower. It has been shown that the North Atlantic States have no very great reserve of undeveloped hydro-electric power, and must continue to depend upon the generation of steam for the operation and expansion of the greater part of its industries, but if the regions of the West where water power is immeasurably more plentiful should develop it so as to supply power for its industries and thus dispense with coal except for purely electric purposes it would automatically release an important share of the coal supply to relieve the shortage of coal in the populous States of the Eastern region of the country.

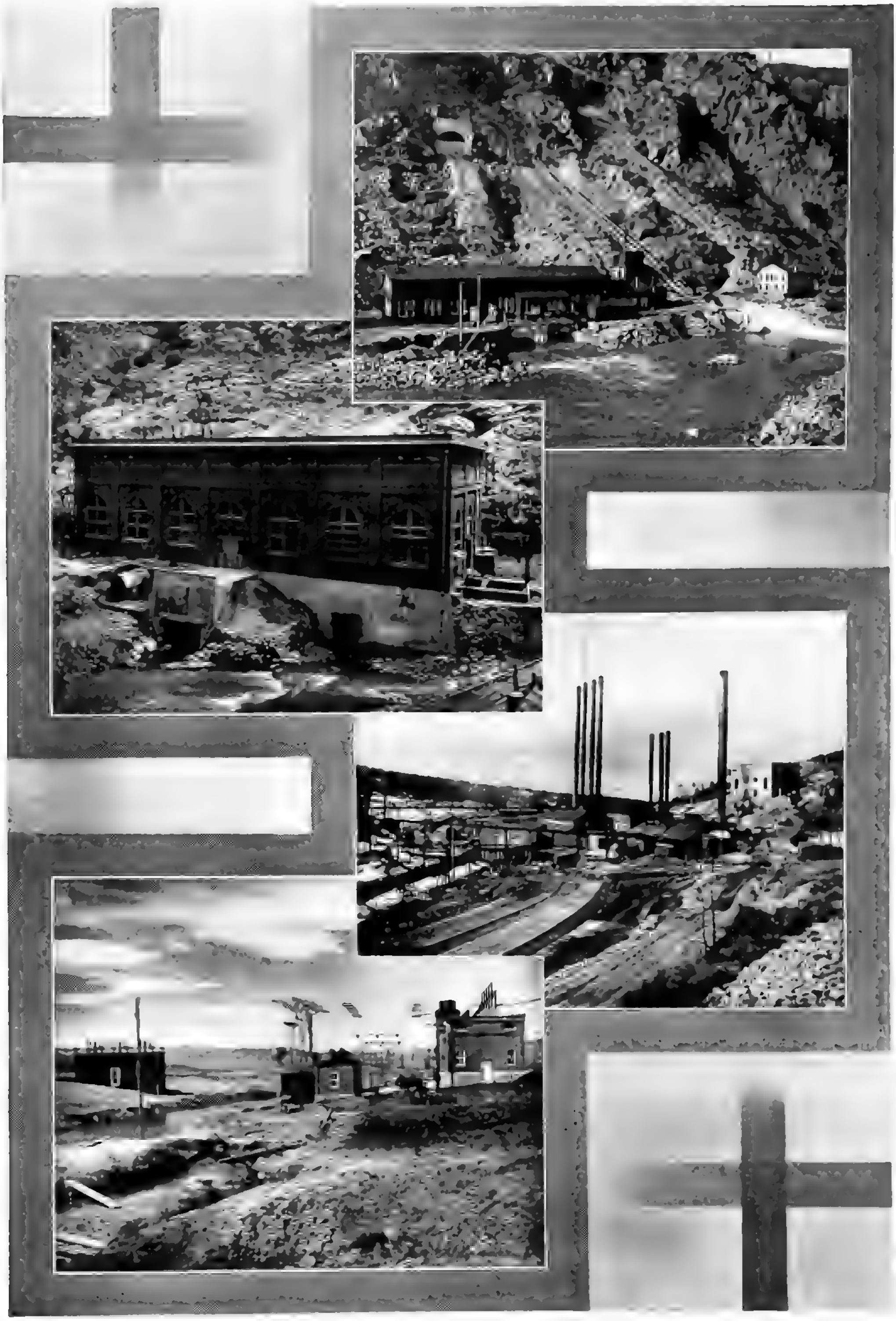
As coal for industries is so expensive and inaccessible in the Inter-Mountain region, and the water-power situation so favorable, electrical industries in that region illustrate most forcibly how the use of hydro-electric energy saves coal. An announcement made by the Utah Power and Light Company in regard to this feature shows that during 1917 the Company generated 500,000,000 kilowatt hours of hydro-electric power. It states that if the same amount of power had been generated by the use of coal in a steam-driven plant it would require the use of a million tons of coal additional to that now used in its territory, or 25,000 carloads: meaning that a coal saving of 83,333 tons or 2,083 carloads per month, or 2,740 tons (69 carloads) per day has been effected by the company's use of hydro-electric energy which it distributes for light and power purposes.

But while water power resources in this country are physically abundant there has been little development of them because of laws which have discouraged or entirely prevented their utilization. Fear of a monopolization of these water powers by exploiting combinations led to measures which under a policy of conservation discouraged water-power development. Litigation to test the validity of this legislation has been pushed for years until recent decisions of the Supreme Court have upheld the Government's contentions. Since then Congress and the executive departments at Washington have been working together to secure action which will provide for a leasing system with a certain tenure (probably fifty years) and other provisions which while retaining title and control in the Government, through a water-power commission, at the same time will serve to encourage, rather than retard, water-power development. As such enterprises must be financed by private capital very little in the way of development of the 40,000,000 or more horsepower in the thirteen Western water power States can now be effected. But with a wiser and more liberal policy there will doubtless come a great development of the water powers. There is no industrial possibility which can do more to benefit the nation and its approach to the highest ideals than that bound up in the future development of the great water powers by electricity.

THE COLORADO POWER COMPANY

This is the story of electric power development in Colorado, a state noted for its natural wealth, thriving industry, general prosperity and the inevitable western push. The Colorado Power Company, if not describable in superlative terms as to size and investment, is nevertheless one of the very important enterprises utilizing the water power resources of the Rocky Mountain region. In respect to the future it stands upon the threshold of great possibilities for the extension of hydro-electric power. At present the company retails power to the mines of Lake, Summit, Eagle, Boulder, Clear Creek and Gilpin counties, to the smelters at Leadville and Salida and to the Denver and Rio Grande shops and yards at Salida and Alamosa. It also serves a major portion of the electrical load of the Denver Gas and Electric Light Company and supplies about one-fourth of the power required by the Denver Tramway Company. That is not all. Of the gradual growth and expansion of the company's service more is to be said. The Colorado Power Company was organized in 1913, acquiring the properties of the Central Colorado Power Company and the Leadville Light and Power Company. The antecedent circumstances leading up to the present organization go back to 1906-07. From then until 1910 was the period when the physical foundations were laid; when brain and brawn were pitted against the elements to accomplish some of the most daring engineering feats ever undertaken. There were even engineering authorities who declared the difficulties insuperable; but the Shoshone and Boulder power plants were the result, forming a nucleus of plants later to be constructed, all being built for cooperative operation. The construction was carried through under the management of the Central Colorado Power Company. Action began on the Shoshone plant, completed July, 1909, and built to utilize the fall of the Grand River ten miles above Glenwood. Here was a deep canyon illuminated with sunlight only an hour or two daily, hardly a habitable camp site, and laborers, therefore, hard to get, added to which were tasks to tax the strength and endurance of the strongest. Protracted excavation through solid rock was undertaken, as witness the remarkable concrete lined tunnel running two and a half miles from the intake dam at Shoshone down the canyon and into the forebay at the power plant. The tunnel was designed to carry 1250 cubic feet per second. The power plant above Glenwood operates at 170 feet head, uses only the regular flow of the Grand River and generates 12,000 k.w., except during the short low-water period of the year. The drainage area of the river above the plant is 4500 square miles.

The Boulder generating station, unlike the Glenwood or Shoshone plant, was intended to be primarily a peak-load and emergency plant. Almost entire dependence is placed upon a very large water storage, as the minimum flow of Middle Boulder Creek supplying the water is as low as 5 cu. ft. per second in dry seasons. The principal reserve is the Barker reservoir with a holding capacity of 520,000,000 cu. ft. and held in by a concrete dam 177 feet high. From Barker reservoir along Boulder Creek—a canyon 1500 to 2000 feet deep—and across the mountains runs a 3-foot concrete gravity pipe line, made in sections at the camps and carried to position. The line is 12 miles long, terminating in a second and smaller reservoir, the Kossler Reservoir, at the head of a pressure pipe line above the power house. The latter, a steel pipe line two miles long, was completed only after the overcoming of unforeseen difficulties. Of unusually heavy material in the first place, some difficulty was found in calking the field joints. Oxyacetylene welding was resorted to in order to make these joints absolutely safe and tight; half the line was gone over and probably the biggest welding job of its kind ever attempted accomplished with the use of five to ten tons of metal. The Boulder plant, rated 10,000 kw. and operating under 1830 feet static head, has two of the world's largest water wheels of the impulse type, each of 10,500 h.p., instead of reaction turbines as at Shoshone, and two 5000 kw., three-phase gener-



Power Houses and Substations of the Colorado Power Company

Boulder Power House
Denver Substation

Shoshone Power House
Leadville Substation and Auxiliary Steam Plant

ators giving 4000 v., 60 cycles. Boulder is also a permanent plant and constitutes a valuable reserve against any failure of the Glenwood plant. Both plants are of permanent and conservative types of construction.

The most acute problems of any encountered in all the constructive work of the period were those having to do with the high-tension transmission lines, transmitting energy at 100,000 v. over an aggregate length of 182 miles. The line from Glenwood to Denver runs 153 miles through the roughest country imaginable, crossing the Continental Divide three times; while on the other hand the line from Boulder on the eastern slope of the mountains traverses 29 miles of less difficult terrain. On the first line herculean labor was involved in carrying materials and erecting the steel towers on precipitous mountain sides and at elevations as great as 13,600 feet. Furious storms and violent 100-mile winds frequently assailed the workers. A number of long spans, one of 2900 feet, were made, but later some were found ineffective owing to severe climatic conditions and additional towers had to be erected. On the Argentine Pass, the third crossing of the divide, steel wire was used. There, too, on a second or reserve line three miles long, strange manifestations of static electricity were sometimes observed with the line disconnected, the discharge occasionally leaping two feet from the wires. The Denver-Glenwood line was one of the first to use suspension insulators, and the Hewlett disc produced by the General Electric Company was adopted with good results. The two 100,000 v. lines from Glenwood and Boulder converge at the Denver substation, which has a wholesale capacity of 15,000 kw. and, in addition to serving the public utilities of Denver, has 30 miles of 13,000 volt power lines serving retail power customers and industrial communities in the vicinity. At Utah Junction, close to Denver, the company supplies power for important electro-metallurgical operations producing ferro-tungsten, ferro-manganese and similar alloys. Between Glenwood and Denver the line makes a loop into the Leadville substation, the first built and one which may be used as a switching station to divide the line in an emergency. The capacity is 4500 kw. The station has 58 miles of 6600 volt power circuits and 19 miles of local distribution in Leadville. The company's power facilities have made possible the milling and preparation of low grade ores formerly of no commercial value. Interesting loads are carried in the mining districts, from which comes an enormous output of precious metals. The Dillon substation was built to supply energy to the mines of Summit county, having 63 miles of 13,000 volt power circuits. Idaho Springs substation serves a subsidiary, the United Hydro-Electric Company, which has 80 miles of 11,000 volt power circuits and 24 miles of local distribution circuits in Idaho Springs, Georgetown and Silver Plume. The Boulder substation has 94 miles of 13,000 volt power circuits. The tungsten camp at Boulder has a world record for production. At Salida are two small hydro-electric stations of 1200 kw. capacity, and at Alamosa a steam plant of 415 kw. for distribution locally and at Monte Vista. Summed up, the main system carries a maximum load of 23,000 kw.; Shoshone normally generates 66,000,000 kwh. and Boulder, 28,000,000 kwh. a year. Periodic additions have been made to the Colorado Power Company's properties since 1913. The Salida Light, Power and Utility Company was acquired that year and merged in 1915, and acquisition of the Mutual Electric Light and Power Company of Alamosa followed. In 1916 the company purchased all the stock of the United Hydro-Electric Company, which had formerly bought energy at wholesale, and now operates the service in the mining country around Idaho Springs, Georgetown and Central City. Another purchase was made in 1916 of the electric light and power plant and business at Sterling, Colorado, a thriving agricultural district in the Platte River valley.

The Colorado Power Company's sources of revenue are well diversified. All important contracts run from five to twenty years and the present corporation has fin-

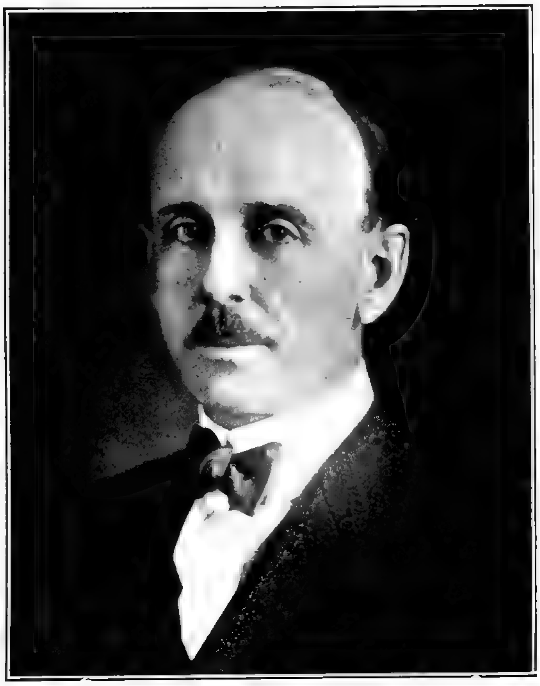
anced all acquisitions and improvements of property from its own resources since its inception. So it will be seen that the company is organized on a firm basis and is in an excellent position for continued growth. George H. Walbridge is chairman of the Board and L. P. Hammond, president. The general offices of the company are at Denver. The New York office is at 25 Nassau Street.

HYDRAULIC POWER COMPANY OF NIAGARA FALLS

Two hundred and forty years ago the admiring eyes of Father Louis Hennepin, French priest, missionary and explorer, were turned upon Nature's most wonderful exhibit of beauty and power—the Falls of Niagara. He was the first white man to see them, his visit being in 1678, but Champlain, who had explored the St. Lawrence seventy-five years before, had heard of them from the Indians, and made noncommittal mention of their rumored existence in 1603. But Hennepin, who really saw it, declared it to be most inspiring spectacle he had ever seen. It was beautiful, it was powerful; but as to any use which Father Hennepin could conceive for it there was none. It was a great spectacle; but, after all, in the estimation of the Seventeenth Century, it was just a waste of water falling over rocks. If it had any economic aspect, it was an unfavorable one, being an obstruction to navigation, making necessary annoying detours and portages for the way-weary traveler. It was nearly fifty years before anybody went so far as to appropriate a small part of the power of the cataract for industrial purposes. A Frenchman dug a small semicircular canal a little above the Falls, and from that canal adventure a primitive sawmill resulted. This sawmill constituted the sole industrial use made of Niagara's power possibilities from 1725 until 1805, when another sawmill was built. A grist mill followed in 1807 and a paper mill in 1825. Other establishments of a similar kind followed, but each was small and the total was insignificant until recent years, when modern engineering science, mechanical and electrical, opened the way to a most substantial realization of means to use effectively the power of Niagara Falls. Of the existence of the power there never was any doubt, but of the possibility of its utilization there was considerable doubt in many minds. DeWitt Clinton recorded in his journal in 1810 that Niagara Falls was "the best place for hydraulic works in the world," but DeWitt Clinton was a man whose visions were ahead of his time. He was the father of the Erie Canal, which was long derided as "Clinton's Folly," but which he afterwards carried to triumphant completion as Governor of the State. Augustus Porter, who owned an estate of three hundred acres at Niagara Falls, and who had, early in the century, built the sawmill of 1805 and the grist-mill of 1807, saw Clinton's statement and felt encouraged by it to make several offers to capitalists. In 1842 he suggested development of power from the river upon a large scale, and later gained the coöperation of Peter Emslie, a civil engineer, publishing a plan for the purposed development. Horace A. Day was the man who finally undertook the building of the canal. The heirs of Augustus Porter gave a right of way one hundred feet wide through the village of Niagara Falls and more land for a basin at the proposed terminus of the canal. Day and his associates organized the Niagara Falls Hydraulic Company on March 22, 1853, and began work on April 20th of that year. The canal, completed in 1861, was thirty-five feet wide, eight feet deep, and 4,400 feet long. The enterprise was not commercially successful in the hands of Day and his associates. The opportunities for manufacturing by means of the cheap power afforded by the canal were not utilized, except by a flour mill built by C. B. Gaskill in 1872. It was fifteen years after the completion of the canal before its power was put to use. This came about by a change of ownership, the hydraulic canal property being purchased by Jacob F. Schoellkopf, of Buffalo, in 1877. Jacob F. Schoellkopf was one of those men of foresight, energy and initia-

PAUL McJUNKIN

Tungsten and molybdenum, that duo of related elements embodied in our high-powered incandescent lighting, have been the subject of the most absorbing study and investigation on the part of Paul McJunkin. In the course of a practice as consulting engineer, begun in 1903, he has concentrated effort upon the development



PAUL McJUNKIN

of equipment and processes for the manufacture of incandescent electric lamps. His office and laboratory are situated at 15 East Fortieth Street, New York City.

Mr. McJunkin is much more than a seeker after commercial success. He is a scientist for science's sake, has followed and participated in each step of growth in his especial branch of investigation. At Vienna, Austria, in March, 1906, Mr. McJunkin was one of the first few persons to witness the illumination of electric lamps with pure tungsten filaments as they burned in the laboratory of Johann Kremenezky. The filaments of these lamps were made by Dr. Hans Kuzel with his colloidal process, a method of manufacture which guaranteed extreme purity in that the tungsten was precipitated from solution in the highest state of chemical purity possible, and the very finely divided metallic tungsten, with only colloidal tungsten as a binder, pressed into threads, dried and then, by the passage of an electric current, sintered into a homogeneous tungsten filament. That same year (April, 1906) Mr. McJunkin brought three of Dr. Kuzel's lamps to America. They were the object of great interest to all electrical men privileged to view them, and, so far as ascertainable, were the first pure tungsten filament lamps to be seen here.

Mr. McJunkin has a firm faith in the increasing value of tungsten. Acknowledgment and prediction are mingled in his following words: "The commercial production of pure tungsten and molybdenum, compelled by their value as an incandescent lamp filament, has resulted in a very great advance in X-Ray work, thanks to Dr. Coolidge; in a great improvement in phonograph needles, first suggested by Mr. C. H. Humphries; in the replacement of an immense quantity of platinum in electric contacts; has made possible several important pieces of wireless telegraph apparatus, and these metals are destined to play an increasingly important rôle in many of the arts and industries." In a technical booklet describing the properties of tungsten, he cites other diversified applications, including its use for aeroplane cables, wire and ribbon in the heating coils of electric furnaces, the hastening of chemical reactions ordinarily dependent upon sunlight, strings for pianos, etc., *ad infinitum.*

Mr. McJunkin was originally from Iowa, having been born at Sigourney August 2, 1875. He is a graduate of the Massachusetts Institute of Technology, class of 1898, and later pursued post-graduate work in physics and chemistry at the universities of Chicago and Johns Hopkins. His first industrial employment was had in 1899 as supervisor of technical work with the Sawyer-Man Electric Company of Alleghany, Pa. Mr. McJunkin is a member of the Engineers, Chemists and Technology clubs of New York, the Engineers' Club of Boston, the American Institute of Electrical Engineers and the American Chemical Society.

THOMAS FRANCIS MULLANEY

Thomas F. Mullaney, Chief Engineer of the Third Avenue Railroad, New York, who is an expert on the installation and operation of electric surface lines, was born in Ireland, March 3, 1867. He was brought to this country by his parents when one year old and received his education in the common schools of New Braintree and Oakham, Mass. He was apprentice to the firm of McMahon & Carver, tool makers of Worcester, when fifteen years of age, and later while installing machinery in the Thomson-Houston Lynn works, became imbued with a desire for electrical work. He thereupon took up the student course with that company, with whom he remained until after absorption by the General Electric, his term of service with the two concerns being twenty years, during which period he installed or did work for about 100 electric railways and power plants from Bangor to the Pacific coast, among them being the first installations in Boston, Philadelphia, Cleveland, St. Louis, the Chicago Elevated, New York Elevated and the New York Central R. R. He also constructed the Lenox Avenue Railroad, the first underground electric trolley built in New York City. In 1908 Mr. Mullaney was appointed Chief Engineer of the Third Avenue Railroad, a position he still retains. He is the inventor of many devices now in use, and is a member of the Engineers' Club and the Scarsdale Golf and Country Club.

CHAPTER XV

DEVELOPMENT OF HYDRO-ELECTRIC POWER

THE practical application of the idea of power development through the revolution of a wheel impelled by the impact of a jet of water upon it had its inception back four centuries or more in Western Europe. In America the use of water wheels for the development of power for mills of various kinds dates from the earliest years of Anglo-Saxon colonization. The early wheels were of various types previously used in Europe, construction and application being modified to suit the conditions.

No improvements made in America were patented until 1853, when a patent for an impulse wheel for hydraulic power development was granted to an inventor named Atkins. Miners in California had, however, from the time of the gold rush in 1849 made for their own use impulse wheels which they used to drive their mills, several new ideas appearing from time to time until 1860, and later. The ordinary form of wheel, as made by these Californians used flat blocks as buckets. The pioneers of the Golden West found the water powers of the Sierras a great aid to their labors, and were taught by experience and necessity to use them with much success.

By later inventors improvements were made by which a larger percentage of the power capacity of the stream utilized was rendered available for power applications. As a result of investigations and tests made by L. A. Pelton and his associates prior to 1880 a form of bucket with a dividing wedge, known as the Pelton bucket, was evolved, and the impulse wheel known as the Pelton became a standard in its class and entered into general use. Applications of this wheel have been made in various hydro-mechanical ways, but in 1890 the Electrical Period of water power development in America began with two 150 kw. single-phase generators which were installed by the Telluride Power Company, at Ames, Colorado. These generators were operated by Pelton wheels under a 500-ft. head. Another early development, installed in 1891, was at Virginia City, Nevada. The town, which is situated on a mountainside, is noted as the locality where the deepest productive mines of the famous "Bonanza" group of the Comstock lode are located. The mines, driven to low levels to add to the great fortunes of their millionaire owners, experienced water troubles which made further mining in these workings dangerous and costly, the heat and bad air, added to the dampness, making the conditions worse. Arrangements were made with Adolph Sutro to drive a tunnel through the mountain 20,500 feet to drain and ventilate the Comstock mines, and incidentally to tap new veins, at a level of about 1,700 feet below the general surface. It was completed at a cost of $6,500,000. To provide more power for the mill a generating

plant was installed in the Chollar shaft consisting of six 40-inch Pelton wheels driven by water under 1,680 feet head, operating six 100-horsepower, constant current Brush dynamos, running at a speed of 900 r.p.m. The line was carried up the shaft to the mill, about one mile distant.

Among the earliest plants (single-phase) to transmit power to any important distance was one installed in 1889 between Oregon City and Portland, Oregon, a distance of 13 miles, the generator being operated by turbines; another installed in 1891 at Pomona, California, the generators of which were driven by impulse wheels, and the current transmitted to San Bernardino, California, 28¾ miles, at 10,000 volts pressure; another at Telluride, Colorado, 1891, with a transmission of 15 miles; and one at Bodie, California, which went into operation in 1893, with a 120 kw. single-phase generator driven by an impulse-wheel under 350-feet head, the current being transmitted 12½ miles at 3,500 volts pressure.

A great advance was marked in the installation of the three-phase experimental transmission line from Lauffen, Germany, 105 miles to Frankfort, built in 1891. Simultaneously two plants (three-phase) were under construction in America, one in California from Mill Creek to Redlands, 7.5 miles, and one at Guadalajara, Mexico, with 18 miles transmission. Similar plants were, about the same time, being installed in Italy and Sweden.

These early plants established the practicability and value of the hydro-electric plant for long-distance transmission, and problems of engineering improvement for plants of that kind have since enlisted the interested attention of many experts in hydraulic and electrical machinery. For convenience plants are divided into two types; first, the low-head plant, with heads up to 200 feet, in which the water is taken directly from the stream in short penstocks and used in large quantities, requiring the turbine as a water-motor. The second division includes the medium head (with heads from 200 to 750 feet), and high head plants, including all above 750 feet, and using as water motor either the impulse wheel or the turbine. "Head" in this connection, means the vertical height of the column of water above the water-wheel. The range of head determines, at the two extremes, the type of water motor. For units under low head and even of moderate size, 1,000 kw. or under, the turbine is practically the only motor which can be used. For high heads, above 1,000 feet, the impulse wheel is the only motor that is ordinarily used. Between the two extremes both types of wheels are available, with a tendency to use turbines on higher and higher heads as the size of units grows larger. The design of American turbines has made rapid progress toward perfection, efficiencies exceeding 93 per cent having been revealed in various tests.

The size of hydro-electric units has steadily increased. The 3,750 kw. units at Niagara Falls were the largest until 1904, at which date there were numerous water-wheel driven units of 2,000 kw. in the West. The 7,500 kw. unit of the Canadian Niagara Falls plant was placed in operation in 1905. The 5,000 kw. unit at de Sabla, California, 1904, remained a standard in the West until in 1908 the 10,000 kw. units at Las Plumas, California, were put in operation. Numerous units of 12,000 to 13,500 kw. are now at work, and there are units of 17,500 kw. at Big Creek, California. No limit seems to have been reached. A unit of 25,000 kw., with a single runner turbine of 36,000 h.p., was projected in 1913, and manufacturers were ready to build it; and the possibilities of hydro-electric design are illustrated by the actual building of a steam-unit turbine of 35,000 kw. capacity.

The size of power plants has increased at a pace corresponding with that of the sizes of hydro-electric units. From the pioneer plants of 200 to 300 kw. capacity development has brought a condition where plants of 50,000 kw. capacity are common, and the highest American development includes such plants as that at Keokuk, Iowa, with 112,500-kw. installed capacity; that at Cedar Rapids, with 90,000-kw. installed capacity, and the

great Niagara plants on both sides of the National boundary.

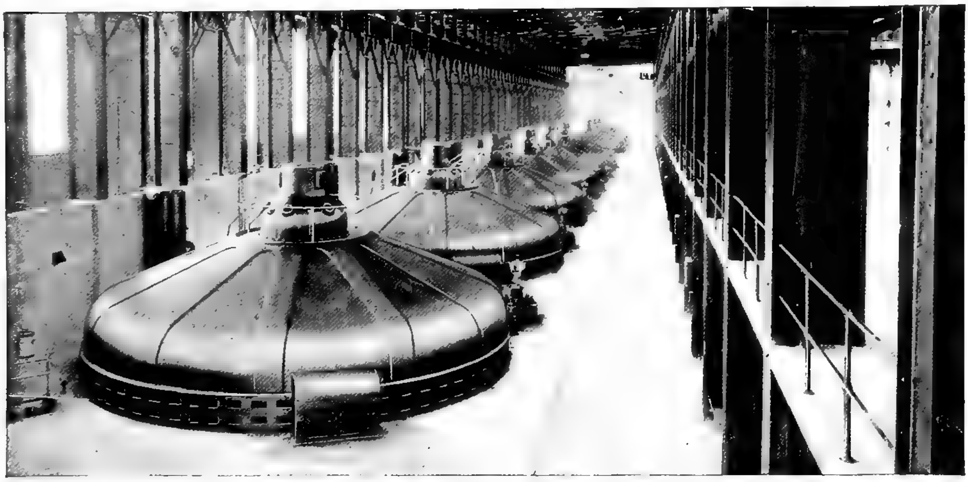
The United States industrial census divides its statistical work concerning the industries and resources of the Nation into five-year periods, and its statistics of those industries that can be classed as "public utilities" are based on their condition and products in the calendar years ending in "2" and "7"; while similar returns concerning manufactures are based on their condition in the years ending in "4" and "9." In these two subdivisions of census results the figures at this writing available are those of 1909 for "manufactures" and "mines and quarries," and of 1912 for "public utilities." The figures, being for different periods, are not quite parallel in application, but are to a certain degree relevant. Thus the Census Bureau gives the total fixed installed primary power, as expressed in horsepower.

Commercial and municipal central electric stations, 1912	7,528,645 h.p.
Street and electric railways, 1912	3,665,051 "
Steam road electrification, 1912	193,956 "
	11,387,655 h.p.
Manufacturing, 1909	16,802,703 "
Mines and quarries, 1909	4,402,554 "
Total fixed installed primary power	32,592,915 h.p.

Of this total the following is water-power:

Commercial and municipal central electric stations, 1912	2,417,081 h.p.
Street and electric railways, 1912	471,307 "
Steam road electrification, 1912	8,000 "
	2,950,388 h.p.
Manufacturing, 1909	1,822,885 "
Mines and quarries, 1909	97,460 "
Total installed water power	4,870,736 h.p.

Charles W. Comstock, in a valuable paper presented before the December, 1916, meeting of the American Institute of Electrical Engineers on "The Future of Water Power in the United States," gives an estimate of the equivalent in fixed power of the power generated by the steam locomotives in service in this country, which he established as being in round numbers, 65,000 locomotives for the fiscal year ended June 30, 1914. Premising that it would be absolutely meaningless, if even the data were obtainable, to add together the rated horsepower of these locomotives as a workable total, Mr. Comstock proceeds by indirect method on the basis of fuel consumed by these locomotives, the cost of which aggregated $242,000,000 in that year. While this included a small proportion of fuel oil, an overwhelmingly large part of this fuel was soft coal. He,



Power House of the Cedars Rapids Manufacturing and Power Company

therefore, assuming $2 per ton as the average price that year, and allowing 26 tons per h.p. year (about 6 pounds per h.p. hour) the equivalent continuous output is estimated at 4,692,000 h.p., or, with a 60 per cent load factor, 7,820,000 h.p., which equivalent of fixed installed horsepower, added to the census estimates of 32,592,915 h.p., would make a grand total of 40,392,915 h.p. for the entire installed primary power of the country, including locomotives. Of that total the installed water power equals 12 per cent.

Water supply paper No. 234 of the United States Geological Survey, by M. O. Leighton, makes an estimate of the water power resources of the United States, and states the absolute minimum of total water power of the United States as 36,916,250 h.p. (based on the stream discharge "for the lowest two consecutive seven-day periods in each year") and an assumed maximum as 66,518,500 h.p., being the quantity which could be generated during six months in the year. Neither of these estimates takes account of storage, which Mr. Leighton estimates would, by the use of all practicable storage sites, bring the grand total of all possible water power development up to 200,000,000 h.p.

The Commissioner of Corporations in 1912 revised the Leighton estimate in a statement of the potential water-power development. One change was the revision of the figures for Niagara, which Mr. Leighton gave as 5,800,000 h.p. minimum and 6,500,000 assumed maximum. As under the present treaty only 25 per cent of the possible power at Niagara Falls can be developed, and of this the United States is entitled to only 36 per cent, the Commissioner corrected these figures accordingly. Other revisions of detail were made for various reasons. The Commissioner's statement took no account of any increase of development to be obtained by storage, which he regarded as "mainly theoretical." Without reference to the additions which storage of water may make available, the Commission arrives at the following figures, stated by groups of States:

States	*Minimum horsepower*	*Assumed maximum horsepower*
North Atlantic...	2,225,000	4,092,000
South Atlantic...	2,344,000	4,256,000
North Central...	1,733,000	3,558,000
South Central....	1,438,000	2,785,000
Western	18,996,000	36,707,000
	26,736,000	51,398,000

This same report of the Commissioner of Corporations arrives at a total of 4,760,000 h.p. for the installed water power in the United States, arranged by the same regional groups, as follows:

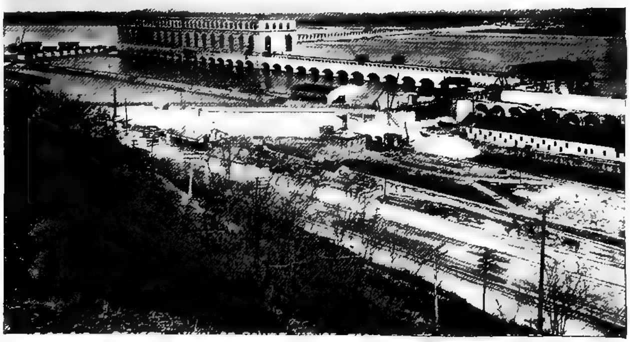
North Atlantic	2,134,000
South Atlantic	589,000
North Central	729,000
South Central	79,000
Western	1,229,000
	4,760,000

By this estimate it appears that the North Atlantic States had already nearly exhausted their water-power resources as expressed in the minimum total above, but the figures are six years old and considerable additions to the volume of installed water power have in the intervening period been made in the North Atlantic States, so that the total of installed water power has already passed the minimum estimated. The omission of any calculation for water power developed from stored waters leaves out an important equation of the water power problem as it has been developed in recent years, for engineers of special competence in the field for hydraulics count upon large increase of water power by the construction of dams and reservoirs to store waters for industrial as well as for irrigation purposes.

Heretofore the developed water powers have been chiefly applied for the purposes of generation and distribution of electric current for light, mechanical power, and, to a certain extent, for heating purposes. Except at Niagara Falls a very small portion of this power development has been for electro-chemical or electro-metallurgical industries. Wonderful results have been achieved in these branches at Niagara and in Europe; the applications of electro-

chemistry and electro-metallurgy through the generation of heavy currents by water power have been very great, but in the United States initiative in these branches has been very slow, until recently accelerated by war needs.

Water-power developments for light, heat and power distribution have only been possible on a large and lucrative scale in locations which are within reach by present transmission methods from large centers of population and industry. Niagara Falls developments had Buffalo and other near-by cities as a distributive area, using the current for lighting and for railway propulsion, although the power was also applied locally in building up large electro-chemical and electro-metallurgical plants, in Niagara's case. Industrial conditions in the Southern States have given rise to the hydro-electric power system of the Southern Power Company, bringing under one control over 100,000 h.p. Very nearly one half of the cotton mills of the South which depend upon outside sources of motive power, and they number 75% of the South's total, are supplied by this company. Production of fertilizer and electro-metallurgical processes are progressing under its protective and fostering influence. The Alabama Power Company, with its one thousand odd miles of transmission, is a great feature of progress in the South and has allied its forces to the manufacturing of high-grade steel. The Colorado Power Company, utilizing the water power resources of the Rocky Mountain region, and located in the midst of mines and towns hungry for power, stands on the threshold of great possibilities for growth. But the other great water-power developments have been practically confined to the satisfaction of urban and intra-urban requirements for light, transportation, heating and the power needs of ordinary city industries. The important plants of the Pacific Gas and Electric Company and its subsidiaries reach fine markets around San Francisco Bay. The Mississippi River Power Co. had a contract for the delivery of 60,000 h.p. to St. Louis before completing the development of its great plant at Keokuk. The McCall Ferry water-power development is within seventy miles of Philadelphia and supplies Baltimore, 40 miles away; and the cities of Seattle, Tacoma and the entire Puget Sound district lie within the direct range of the hydro-electric development at Snoqualmie Falls and kindred plants.



General View of Power House of the Mississippi River Power Company of Keokuk, Iowa, taken from the Iowa Side

According to the statistics already quoted, assuming the lowest estimate of the minimum potential water-power development possibilities and the highest estimate for installed water powers, less than

twenty per cent has been developed without taking into account any possible increase of development to be obtained by storage. In the western region where 70 per cent of the potential water power is located, there has only been a development of 6 per cent. The undeveloped water power resources of that region have no large aggregation of people or industries near them to justify large-scale development for the supplying of light, heat or the power needs of transportation lines or ordinary industries. How, then, can these great sources of reserved energy be profitably utilized?

Without speculating upon the probability of progressive development of methods of electrical transmission of power which will greatly lengthen the distance that can be covered effectively and economically, so that communities much more distant than now reachable may be served, many suggestions from foreign practice and experience may be studied to advantage. The French Alps are remote from large urban populations and the water power developments of that region are actually large and potentially larger. Most of this hydro-electric power is turned to the prosecution of electro-metallurgical processes, chiefly in the manufacture of special alloys; and there are in that section numerous large plants producing ferro - titanium, ferro - tungsten, ferro - molybdenum, and other alloys upon a large scale, one of the operating plants (the Paul Girod Works) itself producing more than two million dollars worth of these alloys every year. It is notably true that the part of our own Great West where there are the greatest number of undeveloped water powers is also precisely the region of the country where raw materials for such metallurgical use are the most profusely distributed.

The three Pacific Coast States alone contain approximately 45 per cent of the potential water power of the country. Their aggregate present development is about 900,000 h.p., leaving possibilities from a minimum of 10,500,000 h.p. to an assumed maximum of 22,300,000 h.p. available for development, without considering the storage factor.

Compare this again with the French Alps development as summarized in Mr. Comstock's paper, before referred to, and quoted by him from the statistics of 1910. There was an aggregate of 475,000 h.p. installed, 80,000 h.p. additional under construction, and 700,000 h.p. projected. Of the power produced 210,000 h.p. was consumed in electro-metallurgical work, 60,000 h.p. in electro-chemical work, 30,000 h.p. in the chemical and wood industries and 165,000 h.p. for commercial power, light and traction.

Compare, furthermore, the Norwegian Nitrate Company, which, in 1913, had 260,000 h.p. already in operation, used solely for the process of fixation of atmospheric nitrogen, and had planned to develop 280,000 additional horsepower for the same electro-chemical purpose. The furnace and process used by the company were not invented until 1903. Mr. Comstock called attention to the fact that although fixation of atmospheric nitrogen has been claimed to be impractical in the United States, that St. Louis, which receives power from the Keokuk plant at $24 per k.w.-year could at that rate produce at a power cost of about $44 a ton of nitric acid, the selling price of which was about $95 per ton.

But it is not necessary to use power transmitted 140 miles to produce nitric acid by the fixation of atmospheric nitrogen. The industry demands cheap power in great quantity, but it is an industry which is capable of indefinite expansion, because the demand for the product continues to grow. The Secretary of Agriculture in his annual report for 1914 called attention to significant facts. The population of the United States had increased 23,000,000 in fifteen years, but the strictly rural districts had shown an increase of barely 6,000,000. More mouths to feed and fewer husbandmen is the most serious problem of the age. The reports of animal industry show an actual decline in numbers of meat animals in the decade from 1899 to 1909 in spite of an increase in population during the same period of more than 16,000,000 people, cattle decreasing from 50,000,000 to 41,000,000 sheep from 61,000,000 to 52,000,000, and hogs from 63,000,000 to 55,000,000.

The acreage of cereals harvested increased from 185,000,000 acres to only 191,000,000 acres or 3.5 per cent, while the population increased 22.4 per cent during the decade. While there are 935,000,000 acres of arable land in the country, only 400,000,000 or 43 per cent were under cultivation. Man-power is needed, but even more vital (because mechanical improvements take the place of man-power very largely) is the need of a constant replenishment of the soil. The war has disarranged our access to supplies of fertilizers, and one of the most important of these is nitric acid. For our supply we depend chiefly on Chile, which would be a menace in case of war and means the payment of export duties and profits amounting to about $5,000,000 annually in time of peace. The production of many of our most highly nitrogenous food products has been steadily declining, and American farmers have been producing less per acre than have European producers. Allerton S. Cushman, speaking on "Water-Power Development and the Food Problem," on April 26, 1916, before the American Institute of Electrical Engineers, said in regard to this problem:

"The food supply depends, in the last analysis, upon the plant food supply. The production of nitrogen, which is one of the three principal fertilizer ingredients, is distinctly a water-power proposition, involving the fixation of atmospheric nitrogen. More than 80 per cent of mixed fertilizer produced in the United States is used east of the Allegheny Mountains, and for the fertilizer problem the water power must be developed in those parts of the country where the demand for intensive agriculture exists. A feasible and proper plan for a water-power development in this country will have a profound influence in the development and distribution of cheap fertilizer ingredients which are so necessary under modern intensive conditions in the growth of population and its relation to agriculture."

Hydro-Electric Station and Development. Little Falls Washington Water Power Company, Spokane, Wash.

We have seen in various instances the prompt and efficient way in which the American manufacturer can rally to the

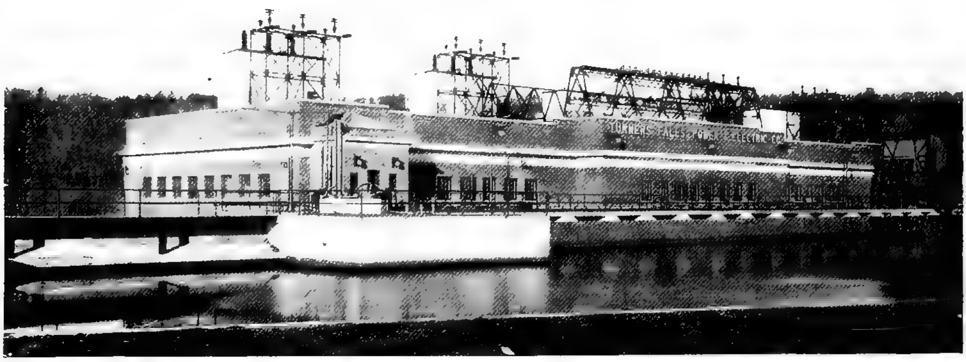
solution of any emergency problem. The war has presented many instances. The thought that we should be forced into a great war which would shut us off from supplies of many necessary things had never occurred to Americans. In some lines, particularly many chemicals, this country had permitted itself to become wholly dependent upon Germany. But when it was found that the dyestuffs and chemicals which had been almost exclusively imported from Germany would be unobtainable otherwise, it did not take American industry long to find a way to establish their production as a home industry. The electro-chemical industries are beginning, for similar reasons, to bulk largely in the industrial thought of the United States, and for their enlargement and great improvement there is a need of cheap and plentiful power; a need which can only be satisfied through hydro-electric equipment.

Hydro-electric plants upon a large scale are expensive to equip, and can only be made to pay when harnessed to industries which are in constant need of large supplies of power, in which case hydro-electric power is almost ideal for large scale production such as is needed in the manufacture of atmospheric nitrogen and in other electro-chemical and electro-metallurgical industries. The first hydro-electric plant in the United States for the manufacture of nitrates was ordered by the Government on February 25, 1918. It was built at Muscle Shoals on the Tennessee River in Alabama on an appropriate power site. The plant, now that the war is ended, will be used for the manufacture of fertilizing material. Our domestic supply is insufficient and it is quite necessary that we engage in large scale production for our own needs.

Almost equally pressing as our actual war need is that of agriculture for nitrogen for fertilizing. Europe has 1,200,000 h.p. developed by hydro-electric energy for the purpose of fertilization of the land, by production of atmospheric nitrogen by the fixation process. This is a process which can be carried on upon a large scale with ample supplies of accessible water power. But there are available means of securing a supply of nitrogen upon a large scale by other means than extraction from the air. The State of Idaho has a large amount of water power available and accessible for the nitrate industry. As those regions are for the greater part remote from coal supply, power derived from steam is very expensive, but in the same region the potentialities of water power are greater and more accessible than in any other region of the country. Much of this water power is under Government ownership and by recent decision is legally reserved from location and private ownership, but the tendency is toward a liberal policy of fostering industrial use of the power under lease, and now that the litigated questions have been decided and those who need the power know what to do and the terms involved, the outlook is for a large increase in Western hydraulic power development in connection with the new alignments of industry by which many of the electro-chemical and electro-metallurgical products formerly supplied to this country from foreign factories will be naturalized in this country. Raw material for the nitrate industry is available in billions of tons of phosphorous rock from which nitric acid can be extracted in large quantities by electrical process. This and many industries like it form the most complete answer to the most frequent objections to the use of far-western water powers because of their remoteness from the large cities of the East and Middle West. As Norway and Chile have been our chief sources of supply it can hardly be contended that Idaho is too remote for the production of nitrates.

The Food Administration, after we entered the World War, kept up an incessant reminder of the duty devolving upon citizens not only to conserve the food supplies but also to increase production. Increased acreage is desirable to that end, but an even more important factor to increased production in emergency is to make production in the areas already under cultivation more intensive. But to do this in the present situation with the existing shortage of farm labor is not an easy task. It may be accomplished to a considerable degree if the soil is enriched by generous fertilization. The average crop of wheat in this country is fifteen

bushels per acre as against a European average of thirty-two bushels per acre, while that continent produces 47 bushels of oats to our 29 bushels. This is partly due to closer attention to more complete pulverization and better care of the cultivation of the crop, but the chief factor is found in the fact that we use only 28 pounds of fertilizer to the acre on an average, while the European farmer uses 200 pounds per acre per annum. There can be no doubt that with intensive farming equal to that of the European farmer (which with our superior farming machinery could be done with less man power here than there), and an equal use of fertilizers, there could be obtained an acreage percentage production equal to that of Europe. If such a production were available the grain problem which proved so serious would have been easily solved. Approach to such efficiency is not possible except by multiplying our fertilizer resources to a degree only possible by the generation of greatly increased resources in hydro-electric energy.



Montague City Station of Turner's Falls Power and Electric Company

Another great use that can be made of the unused water powers is in a greatly increased use of the mountain waters for irrigation. As to the value of irrigation to the arid areas of the West there is no necessity to argue. Deserts that have been made to bloom and produce give eloquent testimony of the practical value of adding moisture to arid areas. But irrigation measures which depend upon gravity flow alone for water distribution leave unirrigated many valuable areas which by developing water powers may be fed with needed water by means of pumps operated by hydro-electric power.

In the greater development of water power the larger success of our manufactures and the greater prosperity of those who labor are intimately bound up. A recent comparison in an English industrial report illustrates in these words: "The only way to increase prosperity is to increase the net output per head of the workers employed. It is possible to increase the output per head by harder work on the part of each individual, but there is far greater promise in increasing his output by giving him more machinery to multiply the effectiveness of his efforts. In the United States the amount of power used per worker is 56 per cent more than in the United Kingdom. On the other hand, not only are the standard rates of wages higher in the United States, but living conditions are better. The best cure for low wages is more motive power. Or from the manufacturer's point of view the only offset against the increasing cost of labor is the more extensive use of water power. Thus the solution of the workman's problem, also that of his employer, is the same, namely, the greatest possible use of power."

Another important feature in the greater development of hydraulic power is the saving of fuel resulting from the development

of hydro-electric power. A recent estimate by Mr. E. W. Rice, Jr., was that the electrification of the railroads of the country would save a million tons of coal annually or about two-thirds of the coal used by locomotives, would permit a speeding up of train schedules of 25 per cent, would eliminate the haulage of coal to the extent of increasing trackage capacity 10 per cent, and otherwise be beneficial in many social and industrial ways. It is not within the range of possibility that hydro-electric power will displace steam horsepower. It has been shown that the North Atlantic States have no very great reserve of undeveloped hydro-electric power, and must continue to depend upon the generation of steam for the operation and expansion of the greater part of its industries, but if the regions of the West where water power is immeasurably more plentiful should develop it so as to supply power for its industries and thus dispense with coal except for purely electric purposes it would automatically release an important share of the coal supply to relieve the shortage of coal in the populous States of the Eastern region of the country.

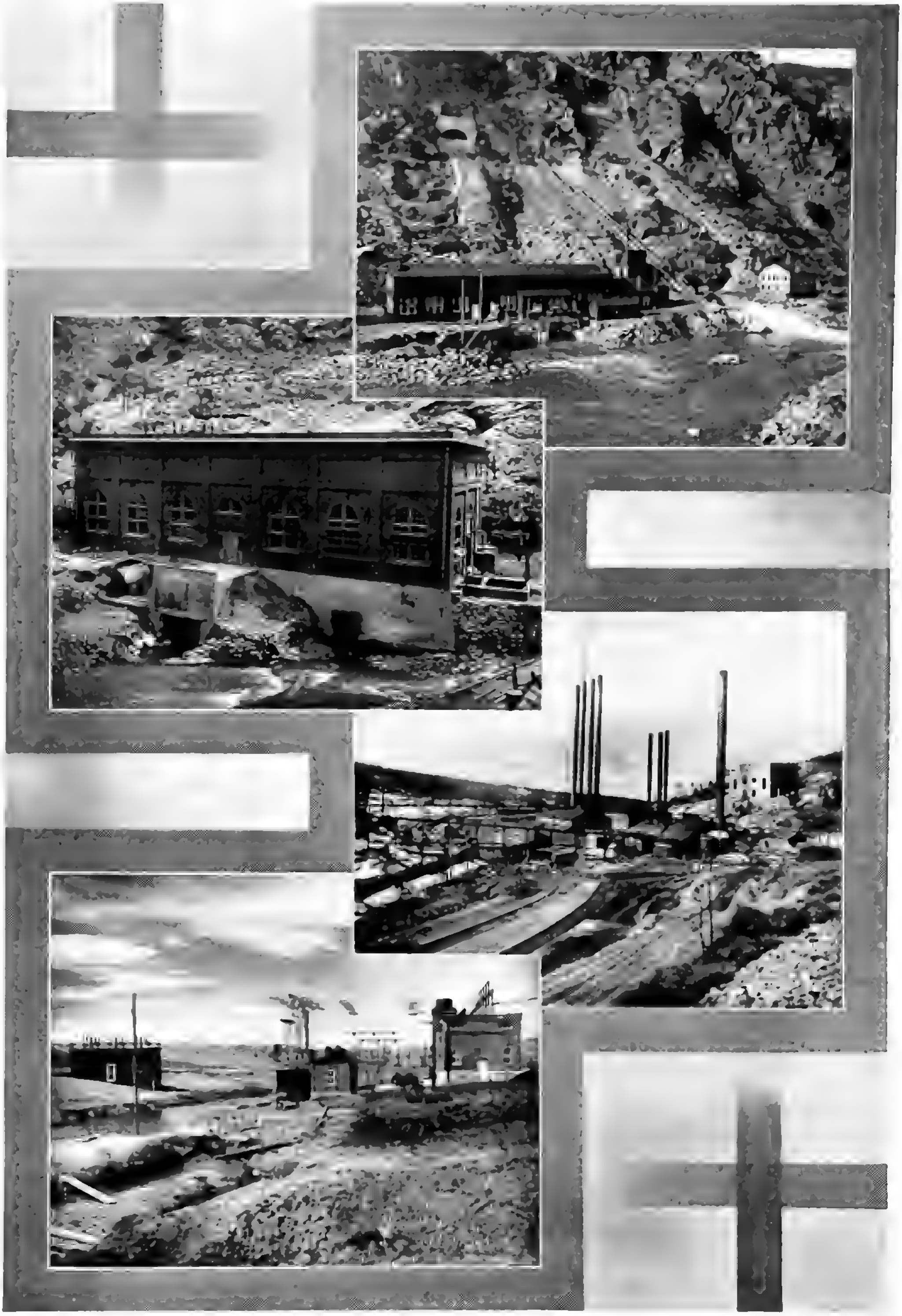
As coal for industries is so expensive and inaccessible in the Inter-Mountain region, and the water-power situation so favorable, electrical industries in that region illustrate most forcibly how the use of hydro-electric energy saves coal. An announcement made by the Utah Power and Light Company in regard to this feature shows that during 1917 the Company generated 500,000,000 kilowatt hours of hydro-electric power. It states that if the same amount of power had been generated by the use of coal in a steam-driven plant it would require the use of a million tons of coal additional to that now used in its territory, or 25,000 carloads: meaning that a coal saving of 83,333 tons or 2,083 carloads per month, or 2,740 tons (69 carloads) per day has been effected by the company's use of hydro-electric energy which it distributes for light and power purposes.

But while water power resources in this country are physically abundant there has been little development of them because of laws which have discouraged or entirely prevented their utilization. Fear of a monopolization of these water powers by exploiting combinations led to measures which under a policy of conservation discouraged water-power development. Litigation to test the validity of this legislation has been pushed for years until recent decisions of the Supreme Court have upheld the Government's contentions. Since then Congress and the executive departments at Washington have been working together to secure action which will provide for a leasing system with a certain tenure (probably fifty years) and other provisions which while retaining title and control in the Government, through a water-power commission, at the same time will serve to encourage, rather than retard, water-power development. As such enterprises must be financed by private capital very little in the way of development of the 40,000,000 or more horsepower in the thirteen Western water power States can now be effected. But with a wiser and more liberal policy there will doubtless come a great development of the water powers. There is no industrial possibility which can do more to benefit the nation and its approach to the highest ideals than that bound up in the future development of the great water powers by electricity.

THE COLORADO POWER COMPANY

This is the story of electric power development in Colorado, a state noted for its natural wealth, thriving industry, general prosperity and the inevitable western push. The Colorado Power Company, if not describable in superlative terms as to size and investment, is nevertheless one of the very important enterprises utilizing the water power resources of the Rocky Mountain region. In respect to the future it stands upon the threshold of great possibilities for the extension of hydro-electric power. At present the company retails power to the mines of Lake, Summit, Eagle, Boulder, Clear Creek and Gilpin counties, to the smelters at Leadville and Salida and to the Denver and Rio Grande shops and yards at Salida and Alamosa. It also serves a major portion of the electrical load of the Denver Gas and Electric Light Company and supplies about one-fourth of the power required by the Denver Tramway Company. That is not all. Of the gradual growth and expansion of the company's service more is to be said. The Colorado Power Company was organized in 1913, acquiring the properties of the Central Colorado Power Company and the Leadville Light and Power Company. The antecedent circumstances leading up to the present organization go back to 1906-07. From then until 1910 was the period when the physical foundations were laid; when brain and brawn were pitted against the elements to accomplish some of the most daring engineering feats ever undertaken. There were even engineering authorities who declared the difficulties insuperable; but the Shoshone and Boulder power plants were the result, forming a nucleus of plants later to be constructed, all being built for cooperative operation. The construction was carried through under the management of the Central Colorado Power Company. Action began on the Shoshone plant, completed July, 1909, and built to utilize the fall of the Grand River ten miles above Glenwood. Here was a deep canyon illuminated with sunlight only an hour or two daily, hardly a habitable camp site, and laborers, therefore, hard to get, added to which were tasks to tax the strength and endurance of the strongest. Protracted excavation through solid rock was undertaken, as witness the remarkable concrete lined tunnel running two and a half miles from the intake dam at Shoshone down the canyon and into the forebay at the power plant. The tunnel was designed to carry 1250 cubic feet per second. The power plant above Glenwood operates at 170 feet head, uses only the regular flow of the Grand River and generates 12,000 k.w., except during the short low-water period of the year. The drainage area of the river above the plant is 4500 square miles.

The Boulder generating station, unlike the Glenwood or Shoshone plant, was intended to be primarily a peak-load and emergency plant. Almost entire dependence is placed upon a very large water storage, as the minimum flow of Middle Boulder Creek supplying the water is as low as 5 cu. ft. per second in dry seasons. The principal reserve is the Barker reservoir with a holding capacity of 520,000,000 cu. ft. and held in by a concrete dam 177 feet high. From Barker reservoir along Boulder Creek—a canyon 1500 to 2000 feet deep—and across the mountains runs a 3-foot concrete gravity pipe line, made in sections at the camps and carried to position. The line is 12 miles long, terminating in a second and smaller reservoir, the Kossler Reservoir, at the head of a pressure pipe line above the power house. The latter, a steel pipe line two miles long, was completed only after the overcoming of unforeseen difficulties. Of unusually heavy material in the first place, some difficulty was found in calking the field joints. Oxyacetylene welding was resorted to in order to make these joints absolutely safe and tight; half the line was gone over and probably the biggest welding job of its kind ever attempted accomplished with the use of five to ten tons of metal. The Boulder plant, rated 10,000 kw. and operating under 1830 feet static head, has two of the world's largest water wheels of the impulse type, each of 10,500 h.p., instead of reaction turbines as at Shoshone, and two 5000 kw., three-phase gener-



Power Houses and Substations of the Colorado Power Company

Boulder Power House
Denver Substation

Shoshone Power House
Leadville Substation and Auxiliary Steam Plant

ators giving 4000 v., 60 cycles. Boulder is also a permanent plant and constitutes a valuable reserve against any failure of the Glenwood plant. Both plants are of permanent and conservative types of construction.

The most acute problems of any encountered in all the constructive work of the period were those having to do with the high-tension transmission lines, transmitting energy at 100,000 v. over an aggregate length of 182 miles. The line from Glenwood to Denver runs 153 miles through the roughest country imaginable, crossing the Continental Divide three times; while on the other hand the line from Boulder on the eastern slope of the mountains traverses 29 miles of less difficult terrain. On the first line herculean labor was involved in carrying materials and erecting the steel towers on precipitous mountain sides and at elevations as great as 13,600 feet. Furious storms and violent 100-mile winds frequently assailed the workers. A number of long spans, one of 2900 feet, were made, but later some were found ineffective owing to severe climatic conditions and additional towers had to be erected. On the Argentine Pass, the third crossing of the divide, steel wire was used. There, too, on a second or reserve line three miles long, strange manifestations of static electricity were sometimes observed with the line disconnected, the discharge occasionally leaping two feet from the wires. The Denver-Glenwood line was one of the first to use suspension insulators, and the Hewlett disc produced by the General Electric Company was adopted with good results. The two 100,000 v. lines from Glenwood and Boulder converge at the Denver substation, which has a wholesale capacity of 15,000 kw. and, in addition to serving the public utilities of Denver, has 30 miles of 13,000 volt power lines serving retail power customers and industrial communities in the vicinity. At Utah Junction, close to Denver, the company supplies power for important electro-metallurgical operations producing ferro-tungsten, ferro-manganese and similar alloys. Between Glenwood and Denver the line makes a loop into the Leadville substation, the first built and one which may be used as a switching station to divide the line in an emergency. The capacity is 4500 kw. The station has 58 miles of 6600 volt power circuits and 19 miles of local distribution in Leadville. The company's power facilities have made possible the milling and preparation of low grade ores formerly of no commercial value. Interesting loads are carried in the mining districts, from which comes an enormous output of precious metals. The Dillon substation was built to supply energy to the mines of Summit county, having 63 miles of 13,000 volt power circuits. Idaho Springs substation serves a subsidiary, the United Hydro-Electric Company, which has 80 miles of 11,000 volt power circuits and 24 miles of local distribution circuits in Idaho Springs, Georgetown and Silver Plume. The Boulder substation has 94 miles of 13,000 volt power circuits. The tungsten camp at Boulder has a world record for production. At Salida are two small hydro-electric stations of 1200 kw. capacity, and at Alamosa a steam plant of 415 kw. for distribution locally and at Monte Vista. Summed up, the main system carries a maximum load of 23,000 kw.; Shoshone normally generates 66,000,000 kwh. and Boulder, 28,000,000 kwh. a year. Periodic additions have been made to the Colorado Power Company's properties since 1913. The Salida Light, Power and Utility Company was acquired that year and merged in 1915, and acquisition of the Mutual Electric Light and Power Company of Alamosa followed. In 1916 the company purchased all the stock of the United Hydro-Electric Company, which had formerly bought energy at wholesale, and now operates the service in the mining country around Idaho Springs, Georgetown and Central City. Another purchase was made in 1916 of the electric light and power plant and business at Sterling, Colorado, a thriving agricultural district in the Platte River valley.

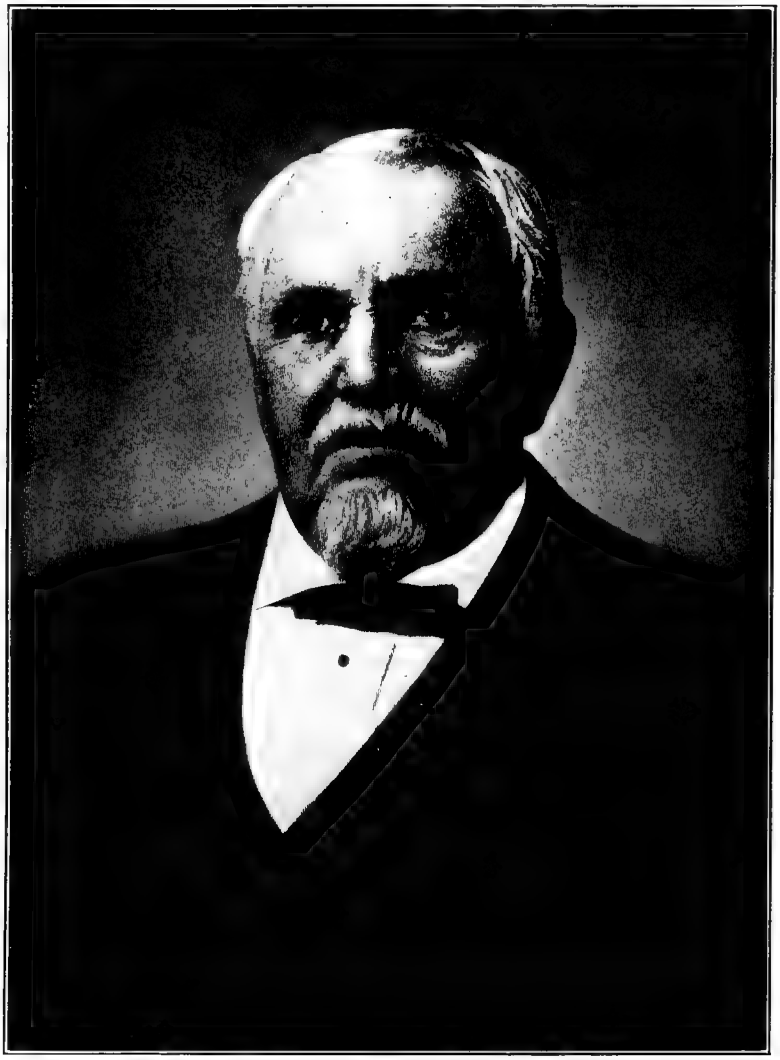
The Colorado Power Company's sources of revenue are well diversified. All important contracts run from five to twenty years and the present corporation has fin-

anced all acquisitions and improvements of property from its own resources since its inception. So it will be seen that the company is organized on a firm basis and is in an excellent position for continued growth.

George H. Walbridge is chairman of the Board and L. P. Hammond, president. The general offices of the company are at Denver. The New York office is at 25 Nassau Street.

HYDRAULIC POWER COMPANY OF NIAGARA FALLS

Two hundred and forty years ago the admiring eyes of Father Louis Hennepin, French priest, missionary and explorer, were turned upon Nature's most wonderful exhibit of beauty and power—the Falls of Niagara. He was the first white man to see them, his visit being in 1678, but Champlain, who had explored the St. Lawrence seventy-five years before, had heard of them from the Indians, and made noncommittal mention of their rumored existence in 1603. But Hennepin, who really saw it, declared it to be most inspiring spectacle he had ever seen. It was beautiful, it was powerful; but as to any use which Father Hennepin could conceive for it there was none. It was a great spectacle; but, after all, in the estimation of the Seventeenth Century, it was just a waste of water falling over rocks. If it had any economic aspect, it was an unfavorable one, being an obstruction to navigation, making necessary annoying detours and portages for the way-weary traveler. It was nearly fifty years before anybody went so far as to appropriate a small part of the power of the cataract for industrial purposes. A Frenchman dug a small semicircular canal a little above the Falls, and from that canal adventure a primitive sawmill resulted. This sawmill constituted the sole industrial use made of Niagara's power possibilities from 1725 until 1805, when another sawmill was built. A grist mill followed in 1807 and a paper mill in 1825. Other establishments of a similar kind followed, but each was small and the total was insignificant until recent years, when modern engineering science, mechanical and electrical, opened the way to a most substantial realization of means to use effectively the power of Niagara Falls. Of the existence of the power there never was any doubt, but of the possibility of its utilization there was considerable doubt in many minds. DeWitt Clinton recorded in his journal in 1810 that Niagara Falls was "the best place for hydraulic works in the world," but DeWitt Clinton was a man whose visions were ahead of his time. He was the father of the Erie Canal, which was long derided as "Clinton's Folly," but which he afterwards carried to triumphant completion as Governor of the State. Augustus Porter, who owned an estate of three hundred acres at Niagara Falls, and who had, early in the century, built the sawmill of 1805 and the grist-mill of 1807, saw Clinton's statement and felt encouraged by it to make several offers to capitalists. In 1842 he suggested development of power from the river upon a large scale, and later gained the coöperation of Peter Emslie, a civil engineer, publishing a plan for the purposed development. Horace A. Day was the man who finally undertook the building of the canal. The heirs of Augustus Porter gave a right of way one hundred feet wide through the village of Niagara Falls and more land for a basin at the proposed terminus of the canal. Day and his associates organized the Niagara Falls Hydraulic Company on March 22, 1853, and began work on April 20th of that year. The canal, completed in 1861, was thirty-five feet wide, eight feet deep, and 4,400 feet long. The enterprise was not commercially successful in the hands of Day and his associates. The opportunities for manufacturing by means of the cheap power afforded by the canal were not utilized, except by a flour mill built by C. B. Gaskill in 1872. It was fifteen years after the completion of the canal before its power was put to use. This came about by a change of ownership, the hydraulic canal property being purchased by Jacob F. Schoellkopf, of Buffalo, in 1877. Jacob F. Schoellkopf was one of those men of foresight, energy and initia-

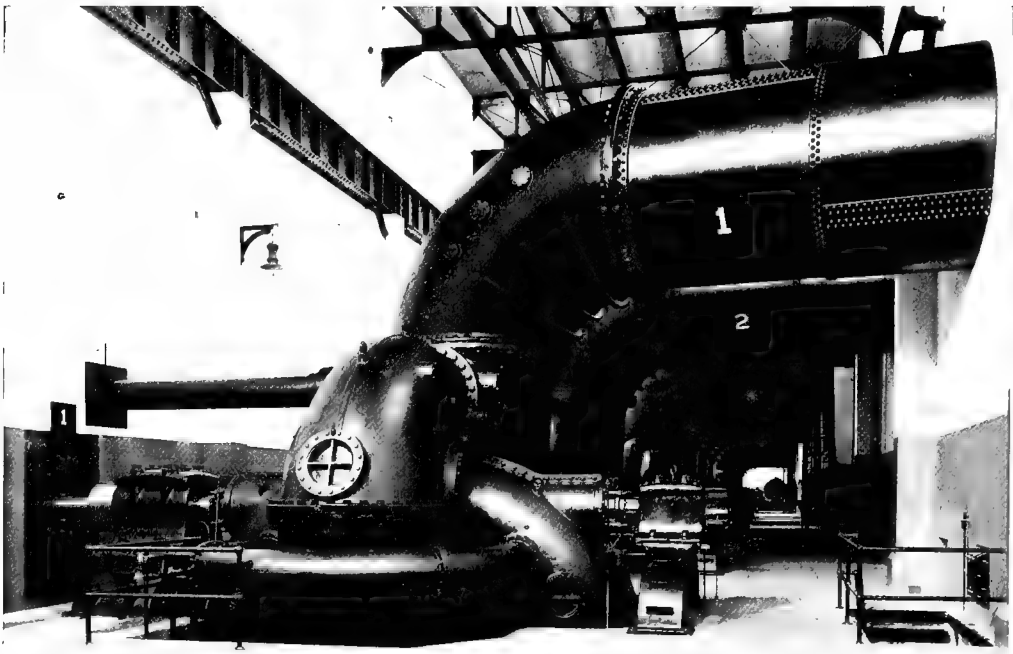


JACOB F. SCHOELLKOPF

Founder of the Hydraulic Power Company of Niagara Falls

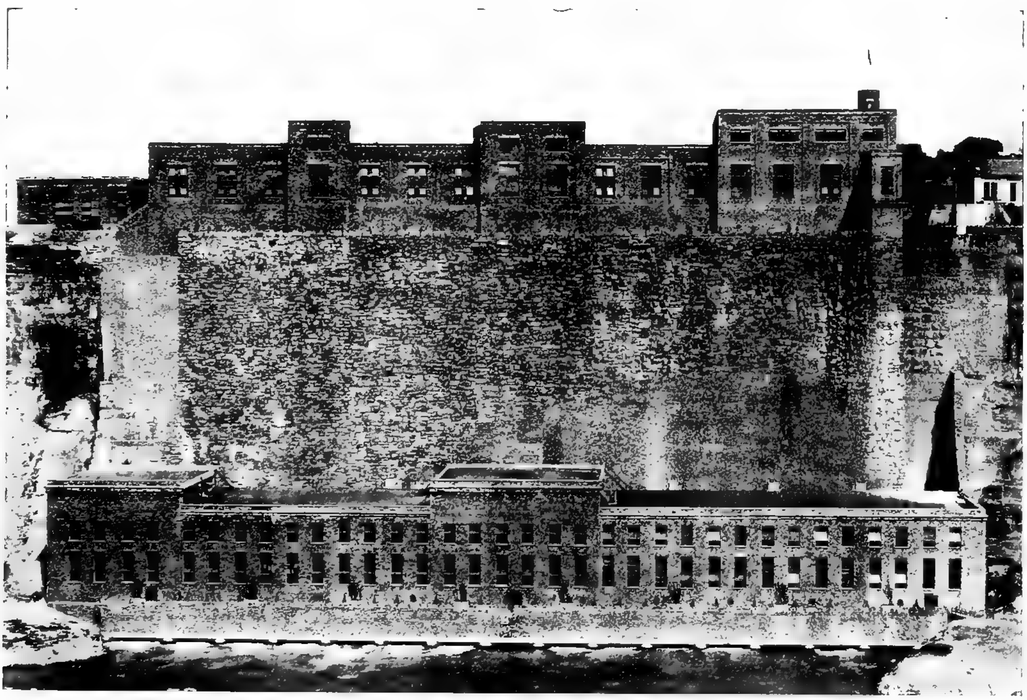
tive who are not only able to architect and construct their own fortune but also to leave permanent impress of their value upon their age and country. He was born in Krichheim, Germany, in 1819, came to America when he was twenty-two years old, and located in Buffalo in 1844. He had no influence or capital to make his opportunities. He had to work for wages to get a start on an independent basis, and by far-sighted enterprise, careful investment, and rigid integrity he became a business and financial leader and a citizen of highest repute. The enterprises in which he was interested were varied. He built houses, stores, shops, tanneries and mills, laid out and constructed highways and had extensive banking interests. When he bought the Hydraulic Canal property everybody knew that it would soon be in active operation. Mr. Schoellkopf was not a man to let an investment lie fallow, and when he acquired the canal he sent his son, Arthur Schoellkopf, then only twenty-one years old, but well trained as a business man, to manage it. For better convenience Mr. Schoellkopf organized the Niagara Falls Hydraulic Power and Manufactur-

ing Company, the title of which was afterwards changed to the Hydraulic Power Company of Niagara Falls, as at present. The development of the power was taken up under the Schoellkopf management. The widening and deepening of the canal was taken up and completed, according to the original intention of the grant made by the heirs of Augustus Porter, to a width of one hundred feet and a depth of fourteen feet. When the State of New York began to be solicitous of its own water-power rights at Niagara Falls the Legislature passed an act confirmatory of the riparian rights of the Hydraulic Power Company, but limiting them to the diversion of an amount of water that could be drawn through its canal at a width of one hundred feet and depth of fourteen feet. The manufacturing activities located to benefit by the water-power developed by the canal were at first purely hydraulic, the electrical development coming later. The earliest of these enterprises was a flour mill, built by Mr. Schoellkopf and his associates and known, then and now, as the Schoellkopf & Matthews mill. It was equipped with 900 horse-power, secured by means of large wooden wheels at first; but iron wheels were soon substituted. These wheels, operating under a head of fifty feet at that time, were nine feet in diameter, placed at the bottom of iron flumes, which were the first iron penstocks ever put into use at Niagara Falls. Later a larger flour mill was erected by the Central Milling Company, utilizing the power developed from a head of eighty-six feet of water. In 1881 the Niagara Falls Hydraulic Power and Manufacturing Company installed the first dynamos to derive their power from the waters of Niagara Falls, introducing, in modest fashion, the hydro-electric industries which have grown to be the most important feature and the keystone of the greatness of Niagara Falls as a manufacturing city. The wheels first put in for this electric installation were too weak to withstand the tremendous impact of the water and were smashed soon after being put in place, and it was only after exhaustive experiment that the company succeeded in securing an equipment sufficiently strong for successful operation.



Water-Wheel Room. Power Station No. 3

This plant furnished power for some manufacturing enterprises and for lighting the village of Niagara Falls. By 1885 there was a total of 10,000 horse-power available from the hydraulic canal. The turbines used in connection with the first electrical installation were placed in pits which were excavated at points from twenty-two to ninety feet down the cliff. The electrical installation of 1885 was a small one compared with that which followed ten years later, but it was a valuable demonstration of a branch of industry capable of almost incalculable extension. Power Station No. 2 was built at the water's edge in the gorge, in 1895, and from its completion dates the wonderful development that has set Niagara Falls at the apex of distinction as a center of hydro-electricity. This station utilized the full two hundred feet head, and its service was used and appreciated by a large number of industries. Jacob F. Schoellkopf lived to see the canal property he had bought developed to this high degree of efficiency, and in 1899 he died, full of years and honors. His life had been useful and constructive. It had been used in the organization and upbuilding of enterprises of usefulness and importance which will endure and be of benefit for generations to come. Especially did his courage and genius bear good fruit in the part he took toward the conversion of the power of the cataract to the service of industry and human comfort. The administration of the affairs of the Hydraulic Power Company had been so organized that before Mr. Schoellkopf's death they had been under the care of his son, Arthur Schoellkopf, who had been trained to the activities of business from boyhood, and who gave the affairs of the company a progressive administration under which the greater development of the electrical equipment was completed. This was accomplished by the building of Power Station No. 3, practically superseding the former installations and ranking as one of the finest electrical equipments in the world, and including thirteen generators of tenant companies, each of ten thousand horse-power capacity, to which the Hydraulic Power Company delivers mechanical power with results



Power-Station No. 3. From the Canadian Side

that show remarkable efficiency. The water from the surface canal flows through gateways into steel penstocks, through which it falls 212 feet upon the water wheels. The generators owned by tenant companies make three hundred revolutions per minute. The power station is 500 feet long, the hydraulic efficiency from headwater to tail-water is 90 per cent, while the electrical efficiency obtained by the principal tenant company is 95 per cent. The water-wheels under steel booms which exclude floating drift or ice, into a housed and heated screen chamber, where it goes through rack which intercept any trash carried by the stream. The water enters the penstocks, which are circular steel tubes leading down over the cliff to the turbines on the floor of the power-house, twenty-three feet above the ordinary level of the river in the gorge. After passing through the horizontal turbines and delivering 90 per

Generator-Room. Power-Station No. 3

of the power plant of the Hydraulic Power Company were built by the I. P. Morris Company, of Philadelphia, and are of the horizontal type. The water from the upper river is carried through a surface canal to the edge of the cliff with a loss of less than two feet in the head, and then to the water's edge in the gorge, thus making possible the use of the horizontal type of wheel, with its inherent advantages. The water from the canal is led from the canal to the penstocks around long curves, and the velocity is changed slowly, with little loss of efficiency. At the gate-house overlooking the gorge the water passes cent of its energy to them, the water is led by draft tubes to the river. Between the discharge of the draft tubes and the river surface a concrete weir is set, the purpose of which is to keep the tube constantly submerged and fully effective in the low stages of the river. The electric generators of the Cliff Electrical Distributing Company connected with the turbine shaft were built by the Allis-Chalmers Company; those used by the Aluminum Company of America were built by the General Electric Company. The plant is defended by the best protective equipment, to secure it against excessive pressure. If at any time the pres-

sure becomes too severe, bursting plates open automatically on the water-wheels and give immediate relief to the penstocks. The Hydraulic Power Company has at all times worked upon the idea of conserving the power it develops for the use and benefit of Niagara Falls and its many industries, and it has thus been a foremost factor in changing the character of Niagara Falls from a mere tourist-sought village to a great manufacturing city. It has consequently worked to increase and improve this industrial development. Arthur Schoellkopf was a most public spirited citizen of Niagara Falls, which he served as mayor. Since his death in 1913 the executive management of the Schoellkopf interests, including the hydraulic canal and associated companies, have been in charge of his son, Paul A. Schoellkopf. The Hydraulic Power Company sells its development of water power to the Aluminum Company of America and to the Cliff Electrical Distributing Company, the latter company distributing the electric power throughout the city of Niagara Falls. In order to facilitate such local use of power the company has purchased and equipped with all municipal facilities tracts of land in the city, which are made available, at very reasonable expense, to industries desiring to locate there. Several important manufacturing establishments have located in Niagara Falls as a result of the efforts of the Schoellkopfs in three generations to make the power of the Falls locally contributory to the building up of the city. They have been the leaders in this local development and have made the place a centre of attraction for those who count the volume and cost of power as vital factors in their industries. Only a little of the water power of the company's canal is used for industrial purposes direct without conversion into the electrical form of energy. Of the factors which have transformed the present time into the Electric Age, the means and instrumentalities which have harnessed the power of Niagara to the wheels of industry and public utility are the most potent demonstration, and this great progress has been pioneered and brought to its full fruition largely as the result of the genius and enterprise of Jacob A. Schoellkopf and his descendants.

CHAPTER XVI

BUFFALO GENERAL ELECTRIC COMPANY

AND

CHARLES R. HUNTLEY

CHARLES R. HUNTLEY, president of the Buffalo General Electric Company, has earned the gratitude of the city of Buffalo. Strong praise is due for the wide-spreading, sky-piercing edifice of brick, steel and concrete on the bank of the Niagara River a half mile north of Buffalo's boundary line and known as the River Station. This gigantic establishment is the steam generating electric plant now furnishing the power which permits nearly 50,000 highly waged operatives to man over 2,000 Buffalo plants.

It required superb faith in the future to expend nearly six million dollars for a steam generating power plant on the part of the executive head of the principal distributor of the hydro-generated electrical energy furnished by the harnessed Cataract of Niagara. Few men are fortunate enough to live to see their own plans justified through the sudden arising of startling conditions, but Mr. Huntley is now reaping the reward. To-day thousands of the busiest men in the world are among Buffalo's manufacturers. Small factories and foundries have doubled, trebled and quadrupled their capacities and personnel, and scores of new factories have sprung up. The untiring pulse which gives life to these centers of energy is the generating plant north of the city line. Over the miles of cable stretching from the giant machinery 80,000 horsepower of current goes forth to turn the lathes, whirl the wheels, drop the hammers and do the other things that electricity does so speedily, effectively and economically. Buffalo knows that her people are busy, knows that orders totaling hundreds of millions of dollars are on the books of her manufacturers, and also knows that wealth flows to her each day; yet few of her leaders ever stop to reflect on the unalterable fact that on the day Charles R. Huntley decided to risk $6,000,000 of the money of his stockholders on a plant that many said was needless, he became a guardian of Buffalo's industrial greatness.

Of this giant plant too little is known, even by those whose commercial life rests upon it. It is, in the vernacular, the "very last word" in steam generating electric plants—a monument to the genius of the late Henry Gordon Stott, who planned its every detail, superintended its construction and died shortly after the completion of his great work. So also is it a monument to that firm of famous construction engineers, Stone & Webster, who astonished the electrical world by breaking ground for this stupendous work in January, meeting difficulties of construction which would have ruined less skillful and resourceful men, and producing power in November of the same year—a feat unprecedented, and scarcely to be hoped for. So also it is a lasting monument to the man who dared to go forward. When the great plant began turning its giant generators

CHARLES R. HUNTLEY

the work of the war was growing heavy and Canada had ruled that Buffalo should suffer a loss of electrical energy in order that Canadian factories might multiply the making of shells, grenades and other war necessities. The Canadian-generated hydro power, hitherto exported across the border, was to be cut off from the Queen City, but a serious crisis was averted when the River Station was found ready to make up the lack. Later more power was retained in Canada and as activities grew at the city of Niagara Falls more power was demanded there. Buffalo would have suffered almost complete industrial paralysis then had not the president of the Buffalo General Electric Company spurred contractors, appealed to Washington for priority orders, urged the great electrical appliance makers to speed up production, and thus made it possible to send forth enough electrical energy to keep Buffalo in the forefront of the great needs of the hour. And not yet content, he is urging on a body of experts who are placing still another unit, the largest single steam dynamo in the world, it is said, to cost over one-half million dollars. Twenty-seven freight cars were needed to transport it and its condenser, and when it goes into commission 50,000 additional horse-power will be available to move Buffalo still further along to her destined place among the four or five leading manufacturing cities of the world. Mr. Huntley may be frankly proud of his company, of its progress, of its popularity, and of his great River Station. This is not only justified, it is also prophetic, for it has now been demonstrated that before many years there will be an unbroken chain of vast industrial plants along the Niagara River from Buffalo to the Cataract City itself. They are working nearer to each other, year by year, and some huge plants are now being constructed on land immediately adjoining the River Station.

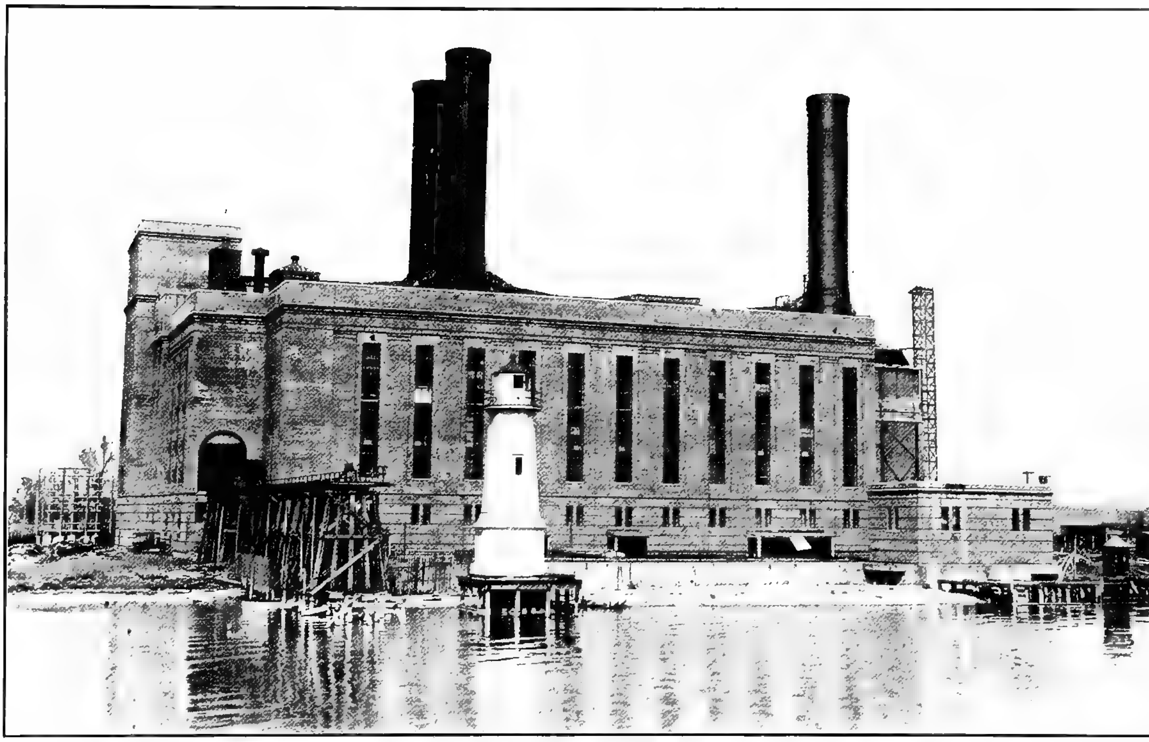
The River Station was planned for 200,000 kw. capacity, three units of 20,000 kw. each, at 90 per cent. power factor (each a horizontal single cylinder, 13-stage turbine) being installed: future units are to be 30,000 or 35,000 kw. The fourth machine will be of 35,000 kw. capacity.

In all probability a world's record was made in the time of construction, for the ground was broken in January, 1916, and the station was put in commercial operation in November of the same year. The late Henry Gordon Stott (deceased January 15, 1917), superintendent of motive power, Interborough Rapid Transit Company, New York City, and associated with Mr. Huntley at Buffalo from 1891 to 1901, was consulting engineer; the Stone & Webster Construction Company, Boston, were the designers and constructors under the general direction of Mr. Stott; Paulding F. Sellers of the Buffalo General Electric Company was the general superintendent on the job, and A. H. Mason, formerly of the General Electric Company, is chief engineer at the station.

Several unusual features of construction are to be noted. Mr. Stott did not cover the turbine steel foundations with concrete as he did those at the Seventy-fourth Street station, New York City. The plant is insured against loss of excitation by Terry duplex exciter sets, each of 300 kw. The governing mechanism of the turbine is so arranged that if power for the induction motor fails, the turbine will automatically pick up the load. The governor on this unit can be adjusted so as to lead any desired amount of steam into the exhaust system up to the full capacity of the turbine drive and yet maintain the emergency feature, that is, adjustment is done on the governor and not on the throttle valve. The exciter turbines use the boiler pressure of 275 pounds with 275 degrees F. superheat. Each condenser has two 25,000 gallon per minute, at 650 r.p.m. centrifugal pumps. Heavy piping at the condensers is supported by springs. The high-pressure steam piping is most impressive. Standing with face to the boiler room wall, one sees the 12-inch steam mains rise 25 feet above the floor —as high as the boiler. Each bend consists of three parts, two 45-degree bends from the horizontal joined by a U-bend of 6 feet 3 inches radius producing a double offset bend with four joints. There are two 12-inch headers or mains, the 10-inch leads from the boilers on one

side of the house going to one of these, and the leads from the boilers on the other side to the other header. One connection from each header joins a receiver at each turbine, with which 15-inch diameter bends connect the turbine.

Because of the setting, large size and great capacity, the stokers are of unusual interest. They are of the inclined under-fed type, two 15-retort stokers being installed back to back under each 11.400 square feet of cross-drum water-tube boiler.



River Station of the Buffalo General Electric Company

It is the largest duplex stoker setting ever built. The furnace width in the grate level is 23 feet 10 7/8 inches. The depth of furnace is 17 feet 5 3/4 inches, in which is that of an ordinary setting. The total grate area is 41.8 square feet and the ratio of grate area of boiler-heating surface is 1.27.3. This is probably the most liberal grate surface per unit area of heating surface used in power-plant practice.

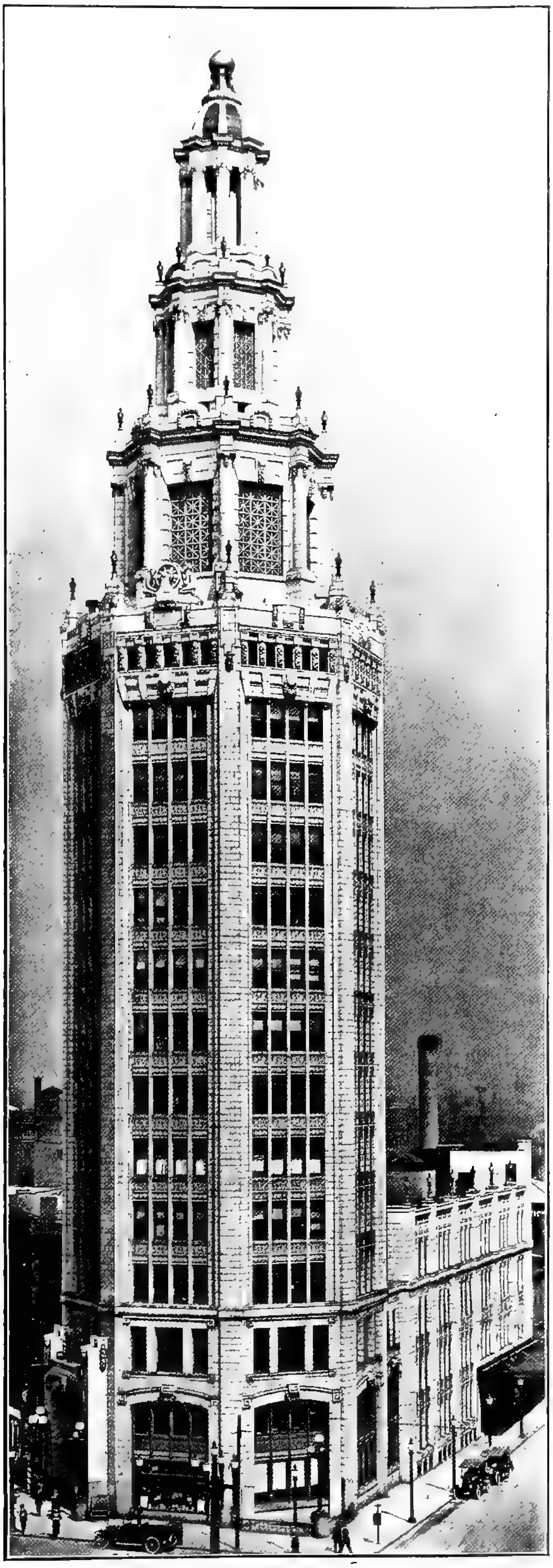
The condensing capacity of the boilers is 100,000,000 more gallons of water a day than the city of Buffalo pumps for her 550,000 people and the bulky electric cables needed merely to transmit the power from this station to its distribution stations cost more money than did Buffalo's greatest hotel. And this is the growth of but a few years, for the commercial use of electricity in Buffalo can scarcely be said to antedate 1887, when the Thomson-Houston Company came into the field. Work on the Niagara Falls Power Plant was started on October 4, 1892. The same year the Buffalo General Electric Company, which was the result of merging the Thomson-Houston and the older Brush Electric Light Companies, had become the sole electric company in the city and Charles R. Huntley, who had arrived from Bradford in 1888, to become manager of the Brush Company, had been made general manager of the new company. It was a struggling company striving, not only to make financial ends meet, but to educate the people of the city to the genuine benefits that would accrue to all were they to adopt this new force for lighting, for the company's product was almost entirely devoted to illumination. The

utilization of this force as a substitute for steam was regarded as unpractical at that time.

The history of this remarkable public utility, thus indicated in the most general way, sums up to a characteristic and unique degree, the whole development of the modern central station for electric light and power, and for the more recent supply of electrical energy to innumerable activities of the most general character. Its close association with the utilization of Niagara, whose currents for at least two-score years have throbbed through its urban circuits, would alone stamp the pioneer work of this company with special merit and luster. Much of the converted energy of the great cataract had primarily, as it still is, to be employed locally, in plants and factories located along the very brink of the rushing Niagara River; but the real fulfilment of every prophecy as to the reclamation for human use of this illimitable source of power was bound up with its transmission to remote points. And heaven knows that in those early days, Buffalo, twenty miles away was remote enough to test sorely every device or principle that the electrical engineer had in his repertory. To-day, Niagara supplies energy to lights and motors and trolleys hundreds of miles to the eastward, "down the State," as well as to far-distant cities in Canada, but the lesson of how to do it was largely learned under the Huntley regime in old Buffalo, in a stern school of experience dating back to the very first efforts to introduce the arc lamp and then to establish the widespread general distribution system needed for the incandescent lamp with its ally, the electric motor. The extent to which the successful development of the great enterprise at Niagara depended upon this cordial reception and appreciation thus accorded by Mr. C. R. Huntley and his colleagues, will probably never be fully realized.

Nor was this quite all, great as was the service not alone to the community directly affected, but to the State, the nation, and all the electrical applications of the Nineteenth century. In a spectacular way, Buffalo had itself prepared the opportunity for the coming manifestation at Niagara with the Tesla two-phase system. Not alone did the company and its manager assist at the first great exploitation of hydro-electric energy, but with characteristic energy and daring, they had many years earlier than that made their plant and powerhouse the scene of the first great convincing demonstration of the advantages and possibilities of the alternating current itself from central stations. We can all remember the interest so intense, and the criticism so far from laudatory, that attended the introduction of the Westinghouse alternators at Buffalo for serious work into the conglomerated menagerie of other growling dynamos for arc and incandescent service, which were soon to be displaced and thrown forever "into the discard." It took nerve and courage of a high order to try out such an innovation against predicted ruin and disaster, with imminent financial risks; but it was put through—and then success came; and a tremendous new era dawned with which the name of Huntley will be forever associated. The recognition and acclamation were immediate, and Buffalo was a goal for all the leaders in the industry, who, being themselves typically alert and progressive, became convinced and then did likewise!

Charles R. Huntley, who wrought this change in Buffalo's industrial condition, was born in Herkimer County, N. Y., October 12, 1854, his father being a prosperous merchant and his mother, Clorinda (Talbot) Huntley, a descendant of one of the oldest families in America. The paternal side of the family is of Scotch origin, the American branch being founded at New Bedford, Mass., about the year of 1657. It is understood that this ancestor died while serving in the Colonial Army during the Revolutionary War, as he never returned to his New Bedford home. Mr. Huntley was educated in the public schools and at the High School, Utica, N. Y., from which he graduated in 1870. His first employment was in his father's store, where he remained for a short time and then secured a position with the Remington Arms Company, at Ilion, N. Y., later becoming representative of the Standard Oil Company, at Bradford, Pa. While in this position he formed a desire to enter the electrical



City Office Building of the Buffalo General Electric Co.

field, and although the industry was then in an embryonic state, it promised to add to the progress and prosperity of the world. Holding these views, Mr. Huntley in 1888 became associated with the Brush Electric Light Company, of Buffalo, becoming general manager of the company in a short time and later assisting in developing the electric industries of the Niagara frontier, through affiliation with the power generating and distributing companies of Buffalo and Niagara Falls. In 1893 the Buffalo General Electric Company was organized and took over the business of the Brush Electric Light Company. Mr. Huntley continued as general manager of the new company and was afterwards elevated to the presidency, at the same time retaining the position of general manager. From its formation until its absorption by the Buffalo General Electric Company, he was vice-president and general manager of the Cataract Power & Conduit Company, and he is still treasurer of the Niagara Electric Service Corporation. He is also vice-president of the People's Bank of Buffalo, director of the International Traction Company, the George Urban Milling Company, the Western New York Water Company, the Erie Finance Corporation, the Marine Trust Company and the General Railway Signal Company of Rochester. Outside of the erection of the mammoth new generating plant, which owes its conception to Mr. Huntley, he takes especial pride in the company's new office building where its executive quarters are located. This structure is fifteen stories high, of semi-classic architecture and is at Washington, Genesee and Huron Streets. Its illumination as a whole is unique and beautiful, while its powerful arc lights at the summit shine out brilliantly over many miles of land and lake.

Mr. Huntley is recognized as an authority on electric matters, his many years in the business having been partly devoted to investigation. His keen observation and power of quick analysis have been of great value to him. In addition to Mr. Huntley's electrical connections, he is deeply interested in anything connected with Buffalo's progress. Despite the many calls upon his time, he derives much pleasure from the development of orchids, heavy-

WILLIAM R. HUNTLEY

producing wheat and three or four other agricultural products. He is a member of the Buffalo, Country and the Automobile Clubs of Buffalo, the National Electric Light Association, of which he is past president, the American Institute of Electrical Engineers and the Buffalo Chamber of Commerce. He was a member of the executive committee of the Board of Directors of the Pan-American Exposition held at Buffalo, and Commissioner of the Lewis & Clarke Exposition, at Portland, Ore. Although taking no active part in politics, he served one term as Select Councilman, while a resident of Bradford, and Mayor Jewett, of Buffalo, appointed him a Park Commissioner, a position he held for three years.

WILLIAM R. HUNTLEY

One of the men who has taken a prominent share in creating the conditions under which the Buffalo General Electric Company has grown to be the institution described, and who has rendered invaluable co-operation to President Charles R. Huntley, is the latter's son, William R. Huntley. It needs no explanation to account for the younger Huntley's adoption of the electrical business as a career. He could hardly have had greater inducement than the excellent opportunities awaiting him in the ranks of Buffalo's unprecedented electric power project. He began at the bottom, has risen high through positions of uncommon trust and responsibility, becoming, while still youthful in years and vigor, the vice-president of the company. His entire life, so far, has been spent in service to the public utilities of Buffalo and western New York State. May 6th, 1879, he was born at Bradford, Pennsylvania, but the fortunes of the family brought him away in time to be raised as a Buffalo boy and educated in Buffalo public and private schools. Two years' service in the operating department of the Buffalo General Electric Company initiated him into the rudiments of the central station industry; and later, as cashier of the company he expanded his knowledge of the art. He entered upon this experience in January, 1899. Steadily familiarizing himself with conditions, by 1906 he had been appointed assistant general manager after having served a period as contract agent. In 1916 he was elected vice-president, and has since been in charge of the operating and commercial departments.

Mr. Huntley's energies, while concentrated in the main upon "General Electric" affairs, reach out into other avenues of related industry, and concern much that has to do with the progress of the great community in which he lives. He is a director of the Buffalo Chamber of Commerce and of the Buffalo Trust Company; vice-president of the Robertson-Cataract Electric Company of Buffalo; director of the Niagara Electric Service Corporation of Niagara Falls; and director of the Syracuse Suburban Water Company. His contact with the electrical fraternity at large is sustained through membership in the Engineers Club of New York; the National Electric Light Association and the Illuminating Engineering Society. Locally, Mr. Huntley is known in the resorts of several recreational and social clubs—the Buffalo, Saturn, Country and Automobile Clubs, and the Niagara Club of Niagara Falls. Mr. Huntley's offices are in the Electric Building, Buffalo, N. Y.

THOMAS EDWARD MURRAY

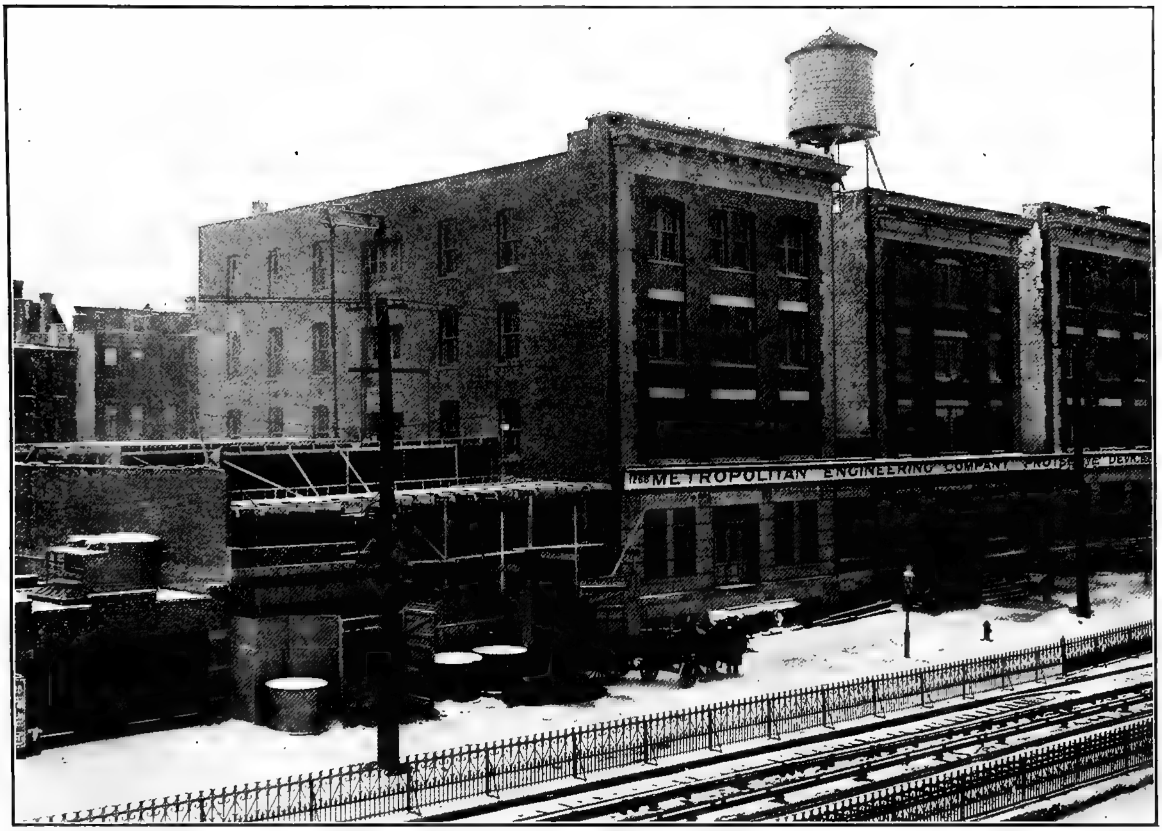
Thomas Edward Murray, Vice-President of the New York Edison Company, was born in Albany, New York, on October 21, 1860. He started work as an apprentice in a machine shop in that city, and, by hard and steady work, he advanced from one job to another, so that at the age of twenty-one he held the position of Superintendent of Water Works at Albany—which seems as if it might be a youthful record. A few years later he became Chief Engineer of the Albany Electric Illuminating Company, also acting as Consulting Engineer for Mr. Anthony N. Brady, principally in connection with electric light and power companies at Albany, Utica, Rochester and Brooklyn, N. Y. Mr. Brady's recognition of any man, meant that that man possessed unusual talent, for his pre-eminent position was attained through the selection of worthy lieutenants. In 1898 Mr. Brady brought him to New York to take the position of General Manager of the Consolidated Telegraph and Electrical Subways Company. In 1899, after Mr. Brady had consolidated the several electric light companies in New York City, Mr. Murray was elected Vice-President and General Manager of the new company, called the Edison Electric Illuminating Company for which he designed and constructed the well known Waterside Stations. The phenomenal growth and success of this company (now the New York Edison Company) is due largely to Mr. Murray's engineering skill, executive ability and business judgment.

As Consulting Engineer, Mr. Murray has a record for big things and is known to have designed and installed more horse power than any other man in the electrical industry. The total amounts to something over 1,500,000 horse power. In this connection he has designed power stations for the United Electric Light & Power Company, the Brooklyn Rapid Transit Company and the Edison Electric Illuminating Company of Brooklyn; also power stations at Albany, Rochester, Utica, Cohoes, Howe's Cave, Troy, N. Y., Louisville, Ky., Dayton, Ohio, and the Prudential Oil Company, Baltimore. He also installed for Mr. Brady the power development on the Tennessee River at Hales Bar near Chattanooga, Tenn., and has also been engaged in the construction of power plants for the different powder plants of the U. S. government throughout the country.

Many of the novel features of these power stations, together with their substations and distributing systems, are the product of his brain and imagination, and he has been granted several hundred patents on various devices, such as protective appliances, seals, cutouts, reactance coils, electric dishwashers, refrigerating machines, cinder and dust catchers, gas washers, elevators, stokers, electrically welded automobile wheels, methods for distilling oil, and methods of electric welding. The multitude of new and improved methods and appliances which Mr. Murray has brought forth is really marvelous, and induces wonder that one brain could evolve it all, however active it may be. More than two hundred of these patents represent electric protective devices, for the manufacture of which the Metropolitan Engineering Company was established about ten years ago. The successful development and reduction to practice of many of these inventions has required a great amount of perseverance and experimental work. In recognition of his work in electric protective devices he was awarded by the Franklin Institute the Edward Longstreth Medal of Merit, in 1910, also the degree of Doctor of Laws from Georgetown University in 1918.

Mr. Murray has served as President of the Association of Edison Electric Illuminating Companies, is a Fellow of the American Institute of Electrical Engineers, and a member of the American Society of Mechanical Engineers.

Mr. Murray's interests are many and varied and include leading financial, railway and commercial organizations scattered all over the United States. He is vice-president and a director of the New



Plant of the Metropolitan Engineering Company, showing the addition to the original building which has now been completed

York Edison Company, Consolidated Telegraph and Electrical Subway Company and the United Electric Light and Power Company. He is a director of the Amsterdam Electric Light and Power Company, and the Edison Electric Illuminating Company of Brooklyn, the Electric Testing Laboratories, the Fort Wayne and Indiana Traction Company, the Heidelberg Cement Company, the Indiana Natural Gas and Oil Company, the King's County Electric Light and Power Company, the King's County Refrigerating Company, the Manhattan Refrigerating Company, the New York and Queens Electric Light and Power Company, the Northern Westchester Lighting Company, the Peekskill Lighting and Railway Company, the Peoples Trust Company, the Union Terminal Cold Storage Company, the Westchester Lighting Company, President and director of the Edison Light and Power Installation Company, President and trustee of the Yonkers Electric Light and Power Company, and trustee of the Emigrant Industrial Savings Bank. His offices are at 54 Wall Street, New York City.

The plant of the Metropolitan Engineering Company, an illustration of which appears herewith, and which Mr. Murray established to manufacture his patented electric protective devices, is located at 1250 Atlantic Avenue, Brooklyn. It is thoroughly equipped with modern machinery especially adapted to the work, employs a large mechanical force and covers a considerable tract of land. The business, however, has outgrown the dimensions of the original buildings, and additions were recently erected on the ground adjoining on the right. Completed the establishment is one of the largest devoted to this character of work in Greater New York.

THE OKONITE COMPANY

After a manufacturer has been producing for a certain number of years with unvarying evidence of quality and dependability in his product, there is accorded him, on the part of the public, or the profession he serves, a recognition, which, although illusive and indefinable, is more real and enduring than any official written or spoken endorsement. It is the silent understanding through which the traditions of famous mercantile houses and manufacturing establishments are perpetuated.

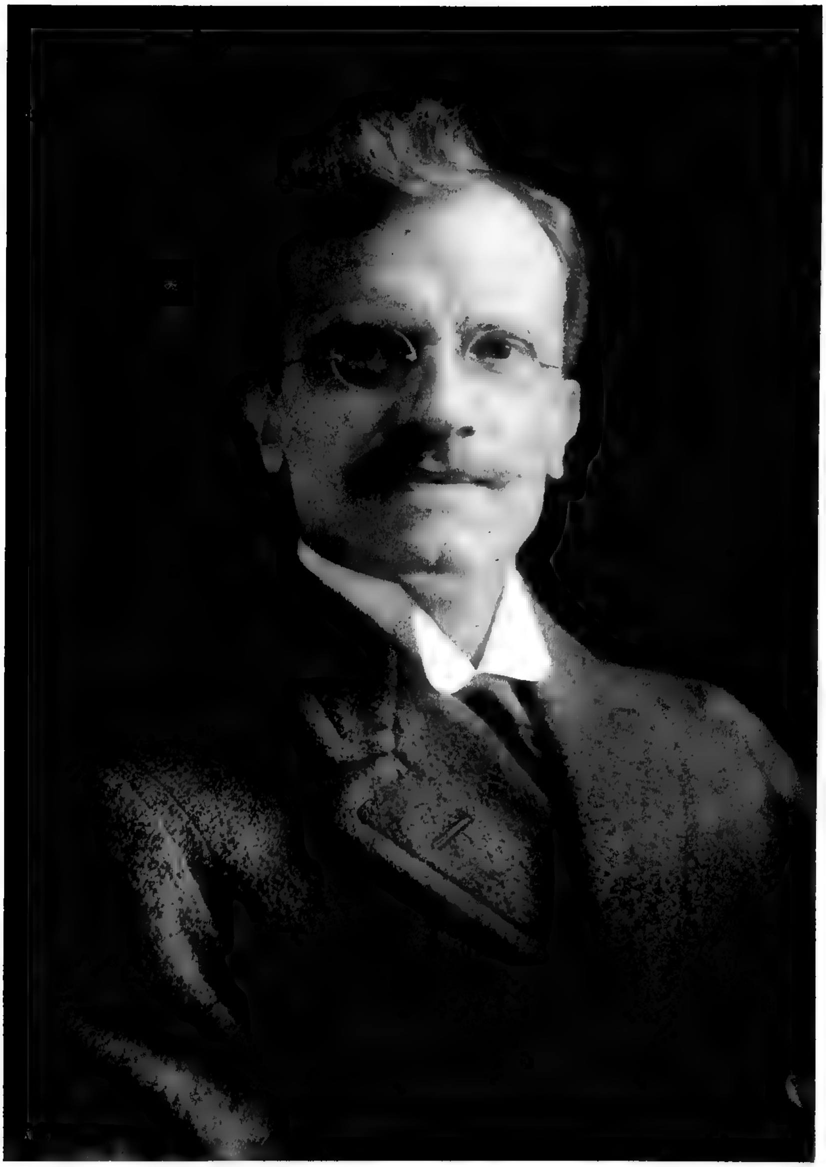
The Okonite Company, manufacturing insulated wire and kindred products over a long period of time, has come to be an industry of accepted reputation wherever these articles are marketed. Electrical men have been familiar with the product of this company and with the personnel of its management since the so-called pioneer days of wire making.

In its recent history H. Durant Cheever figures prominently, adding further to the contribution made by the Cheever family to the progress of the electrical arts in America.

As long ago as the Paris Exposition of 1889, The Okonite Company was awarded a medal for rubber insulation, and a similar award was bestowed at the Chicago World's Fair of 1893. Okonite had then become synonomous with the standard of rubber insulation. The Okonite Company was incorporated in 1884. It is considered one of the country's leading producers of insulated wire and cable. The plant, situated at Passaic, New Jersey, is equipped for making all the dimensions and types of insulated wire in use by the telephone, electric light, power, railway signal and other electrical systems. Accessory specialties of recognized merit are also manufactured there. To mention one, the Manson Tape, named after its inventor, George T. Manson, is a friction, rubber-filled cloth tape used for protecting the joints of insulated wires against mechanical injury. Being adhesive, non-corrosive of copper wire, and proof against unwrapping, it has been widely adopted.

The officers of the Okonite Company, beside H. Durant Cheever, the president, are: Willard L. Candee, vice-president; William S. Brumley, treasurer; and William H. Hodgins, secretary. The Board of Directors includes, in addition to the foregoing names, F. C. Jones, A. F. Townsend and George M. Brooks.

City sales offices are maintained at 501 Fifth Avenue, New York, and the business of the company throughout the country is handled by special representatives. The Central Electric Company, of Chicago, are the general western agents; the F. D. Lawrence Electric Company, are the Cincinnati agents; the Pettingell-Andrews Company and the Novelty Electric Company are respectively the agents in Boston and Philadelphia.



DR. GIUSEPPE MUSSO

DR. GIUSEPPE MUSSO

The telegraph and telephone are no exceptions to the electrical rule that perfection in discovery and invention is still further on. Among the workers who in these fields have attained emphatic progress by fruitful research and successful experiment is Dr. Giuseppe Musso, whose range of work has covered valuable achievement in improving and simplying long-distance telephone and telegraph service. His inventions cover a wide field, and have been coördinated into what is known as the Musso System of Long-Distance Telephony and Telegraphy.

Dr. Musso was born at Vado, in the Province of Genoa, Italy, January 26, 1867. He had the advantages of intensive study under able teachers and received a liberal education. From early boyhood his chief interest as a student centered in scientific studies, especially in the realm of physics. In electrical science and the progress of electrical discovery he mastered all the basic principles and scientific data.

In Italy he had for several years pursued researches which finally became specialized in connection with the problems of telephony and telegraphy. Not only how to do new things, but also how to do old things better occupied his attention. The results of his research were especially effective in the discovery of vitally improved and vastly more economical methods of using existing apparatus and equipment of telephone and telegraph lines for greatly enlarged and much more efficient service. Many of the things discovered by him are basic and revolutionary.

He came to the United States in 1904 and has here carried his experimental researches to much more complete results, culminating in the completion of the Musso System of Long-Distance Telephony and Telegraphy.

Under this system it is possible to telephone from any point to practically any other point in the world by cable and open-wire lines, using existing apparatus. By the Musso system the physical as well as the phantom circuit may be used for long-distance telephoning, making available three circuits, compared with a single one by the present systems. The Musso system also does away with the need for "loading" coils or extra heavy wires for long-distance telephone or telegraph circuits, and, to put it even more strongly, obviates the need for any specially constructed long-distance wires.

The Musso system increases by three times the speed of long-distance overland and submarine telegraph; that is, one cable or open-wire line will do the work of three. The longer the line, the greater the advantage of the Musso over standard systems. It is not necessary to repeat messages sent by the Musso system.

It is said to be possible with the Musso system to telegraph and telephone simultaneously on the same long-distance circuit; and by it both telephoning and telegraphing can be done as easily by cable as by open-wire lines. It is thus possible by the adoption of the Musso system to do away with all aerial lines, substituting cables for them, with the result that damage and interruptions of service as the result of storms could be avoided. A further great advantage is the reduction of original cost of line construction by this system, which requires no heavier equipment for long-distance than for short lines. It is quite feasible, by the Musso system, to telephone to Europe over existing cable lines.

The Intercontinental Telephone and Telegraph Company, Inc., of which Dr. Musso is president, controls the Musso System of Long-Distance Telephony and Telegraphy. The company has arranged to lay soon a submarine cable between Key West, Florida, and Havana, Cuba. The cable will afford six telephone circuits, out of which two telegraph circuits will be derived and operate simultaneously with the telephone circuits.

The cable will be a plain cable, with no inductance loading: Conductor resistance, 9.2 ohms per nautical mile; capacity, 0.33 microfarads per nautical mile; length, 118 nautical miles. This cable will form the first link of a chain of submarine telephone cables leading to South America. The inauguration of telephonic communication between America and Europe is also in contemplation.

THE ROBBINS & MYERS COMPANY

The Robbins & Myers Company owes its existence to the financial difficulties of a machinist who had a small job shop in Springfield, Ohio, back in the seventies. Chandler Robbins had advanced this machinist a small sum of money, and in 1877 he bought the shop to save his investment. A year later J. A. Myers bought an interest in the shop, and the Robbins & Myers Company came into existence under its present name.

In the early nineties the management of the company began to give thought to the proposition of manufacturing and marketing some product under their own name along with their job business. Various articles were investigated and in 1897 a start was made in the electrical line.

At this time the electric fan had become recognized as a promising commercial product, and the company decided to take up the manufacture of fans. The first fan manufactured was a direct current ceiling fan. That this fan was a success is evidenced not only by the rapid growth of this business but also by the fact that these first fans are still found in operation, giving good service in all sections of the country. Oscillating and non-oscillating desk fans and small ventilating fans were added to the line; and a little later a complete line of alternating current fans was added to the direct current line.

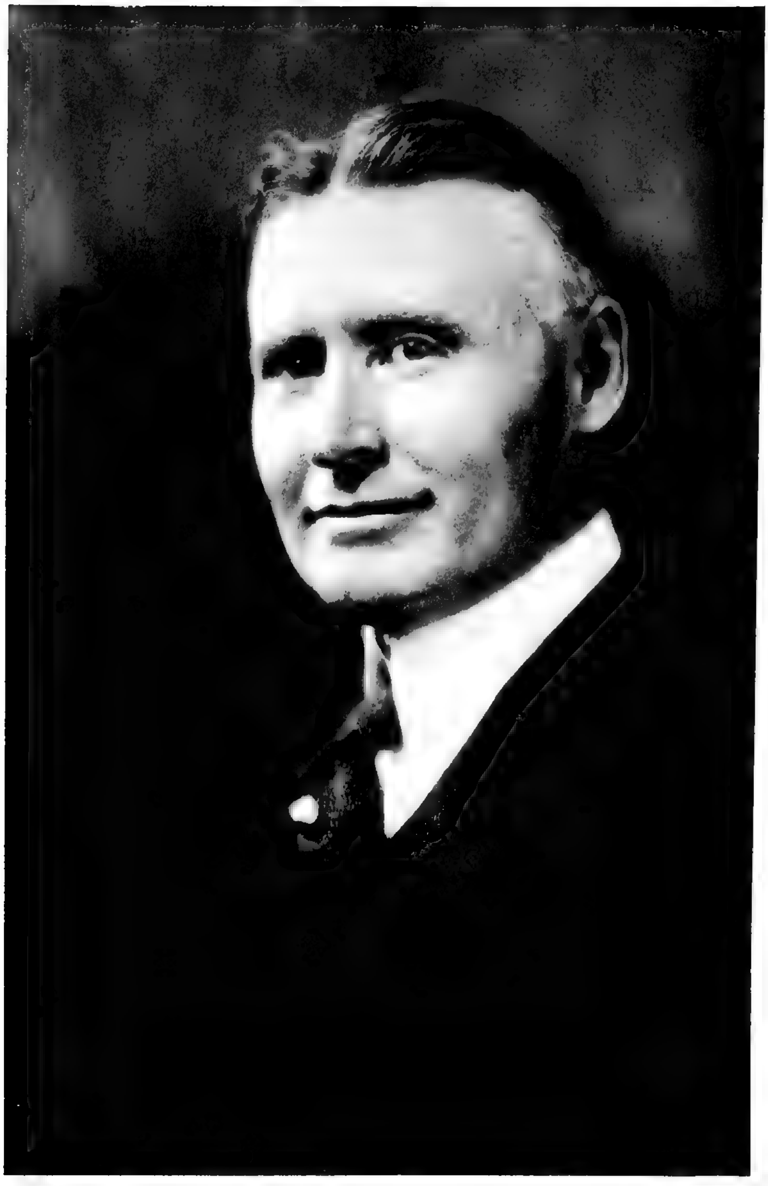
In 1899 the manufacture of electric motors for general power service and small electric generators was begun. The demand for these products increased so rapidly that the original job foundry and machine shop business was entirely supplanted by the motor and fan business. Additional land was purchased from time to time and new buildings were added. Within the past decade all of the original buildings have been displaced and the entire plant is now housed in modern buildings of concrete and steel construction.

In addition to the standard lines of alternating and direct current motors for general power service, the Robbins & Myers Company specializes in the production of special motors for manufacturers of electric-driven machines such as vacuum cleaners, washing machines, adding machines, addressing machines, meat choppers, automobile starters and scores of other electric-driven machines for the home, office, store and factory which require special motors adapted to the services which these machines perform.

As a company which has used advertising as a dominant factor in their merchandising plans, it is interesting to record that the Robbins & Myers Company were also the first of the electrical manufacturers to advertise their products to the general public through national magazines of general circulation.

Until about ten years ago electrical manufacturers had confined their advertising to technical and trade papers and direct advertising to the trade and users of the product. It was generally believed by these manufacturers that it would not be practical to advertise such highly technical products as their manufactures to the general public. The officers of the Robbins & Myers Company did not share in this opinion however, and in the face of much adverse advice, blazed the way for the tremendous volume of general advertising which is now done by the electrical industry. The wisdom of this step is shown by the progress of the Robbins & Myers Company, as it has grown from a company with a capital of $50,000.00 to one with a capitalization of $5,000,000.00 during the ten years it has advertised nationally in mediums of general circulation.

In 1901 the Robbins interests were purchased by Mr. J. A. Myers and Mr. C. F. McGilvray who was employed by the company as Foundry Superintendent. Upon the death of Mr. J. A. Myers in 1904, Mr. McGilvray and the two sons of Mr. J. A. Myers—W. J. Myers and W. A. Myers—succeeded to management of the company. The present officers are: C. F. McGilvray, Pres.; W. J. Myers, Vice-Pres.; W. A. Myers, Secy., and H. E. Freeman, Treas.



HARRY B. LOGAN

HARRY BACHELOR LOGAN

Both Harry Bachelor Logan and Dossert & Company are subjects of interest for the unquestionably useful place that each has held in one of the very practical branches of electrical equipment manufacturing. What each has contributed to the reputation of the other, and what they are both doing today, makes up the sum of the story. With the advance remark that Mr. Logan is and has been for many years the president of Dossert & Company, we revert to the unusual sequence of circumstances leading up to his present position. Born at Zanesville, Ohio, January 5th, 1868, and educated in the town's public schools, he enlisted with the Western Union like other boys anxious to start earning their salt early in life. From carrying messages he was promoted to sending and receiving them, became, in fact, an expert telegrapher at the age of sixteen. After a period during which he served the Associated Press and the United Press Association, his proficiency with the key had become so extraordinary as to bring him the "championship of the world," signalized by the bestowing of a gold medal offered by the Postal Telegraph Company, together with the first cash prize, at the National Fast Telegraphic Tournament of March 25th, 1893. The setting of the event was in Hardman Hall, New York, and it was an exciting affair in those days when the telegraph had not ceased to be one of the "seven wonders." Between 1897 and 1906 Mr. Logan was the chief operator of a large Stock Exchange wire system in Wall Street.

Dossert & Company, manufacturers of Dossert "tapered sleeve" solderless connectors and terminals for electric power conductors, began business in 1905. Mr. Logan was elected to the presidency in January, 1906, and under his direction the company has since specialized exclusively in the design and manufacture of mechanical devices for connecting and terminating electrical power conductors by compression and without the use of solder. The Dossert connectors, made in every necessary size and for all conceivable types of conductors, have been found highly serviceable in power houses, sub-stations, industrial plants, mines—at every juncture on lighting and power circuits where electrically and mechanically dependable connections are a vital necessity. Ease of application, low resistance and absolute permanency of joint recommend them to the engineer. The variety of forms in which these connectors are manufactured, and the range of connecting needs that are provided for, have made possible the solution of many complex problems of wiring and cable installation. The President of one of the great Edison Companies of Greater New York while speaking to a Company Section meeting, referred to Dossert connectors as good examples of the genius of *doing an ordinary thing in an extraordinary way.*

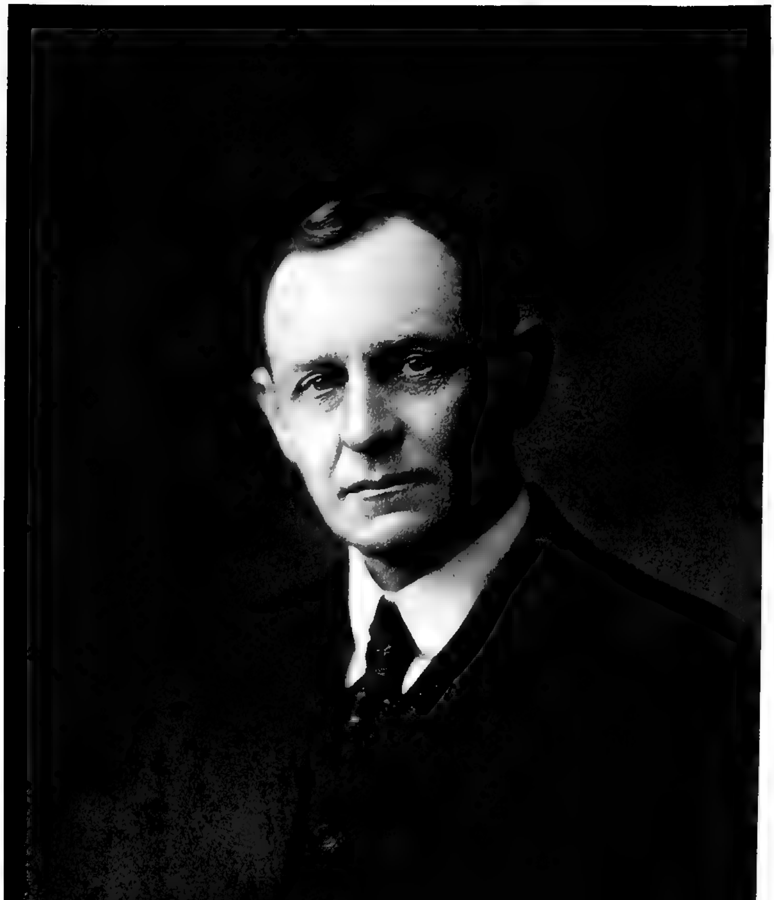
The Dossert "tapered sleeve" solderless connectors have been so widely adopted for connecting feeders to switchboard coppers, short circuiting and ground cables, connections to rotaries, transformers, 2 phase and 3 phase buses, motors, etc., that the list of these products and their description might be extended to indefinite length, but the fact that is inclusive of all is that they are everywhere regarded as the standard equipment of their kind. The approval of the National Board of Fire Underwriters and the National Electrical Code is significant of the reliance universally placed in them.

The man who has had most to do in making this business an integral and progressive part of the electrical industry, Harry B. Logan, is a familiar personality among electrical men. He is an Associate Member of the American Institute of Electrical Engineers and a member of the New York Electrical Society, New York Electrical League, and the Engineers' Club. The affairs of the Ohio Society and the Rotary Club also engage his attention. Mr. Logan's offices are at the sales headquarters of Dossert & Company, 242 West 41st Street, New York.

THE PEERLESS ELECTRIC COMPANY

The advance in usefulness, symmetry and efficiency of the generators and motors of today as compared with the crude and unmatured machines of a few decades ago reflect the concentration of many minds upon the productive endeavors of electrical conquest. As in most other branches of mechanical creation, the first results, great as they were, had many crudities and imperfections, which mechanical genius has, step by step, overcome and eliminated until now the products of the modern electrical manufacturers represent a great scientific and operative progress. This may be aptly illustrated by the accomplishments of The Peerless Electric Company, of Warren, Ohio, whose dynamos and motors constitute a complete and significant expression of the best modern practice in the production of electrical machinery. Warren, Ohio, the county seat of Trumbull County, is one of the thriving cities of what is known as the "Western Reserve" region of Ohio, which are all noted for their manufacturing activities. The city has diversified industries, but has made a leading feature of electrical machinery, supplies and accessories. Among the foremost men of Warren was a group which early came to an appreciation of the opportunities for industrial expansion presented by the electrical supplies industry, and established several enterprises of that kind, of which the Peerless Electric Company, manufacturers of motors and generators, and of desk and ceiling fan motors, is the largest and most successful. The city of Warren has an especially favorable location for industries of this nature in respect of the supply of raw materials of manufacture, and transportation facilities supplied by three trunk railroads as well as local lines. It is the home of an industrious American community, including many descendants of the New England settlers, who founded Warren in 1799. The Peerless Electric Company was organized and incorporated on June 20, 1902, the founders being T. H. Gillmer, former prosecuting attorney of Trumbull County and at that time president of the Union National Bank; E. W. Gillmer, of the same prominent Trumbull County family; E. E. Nash, a director of the Second National Bank; W. C. Ward, a practical and experienced manufacturer; Jacob Perkins, of a prominent Warren family with large local interests; James W. Holloway, retired railroad official and long president of the City Council, and William Wallace, then cashier of the Union National Bank, and now president of the Union Savings and Trust Company. The present officers are George H. Jones, who is also a director of the Western Reserve National Bank of Warren; W. C. Ward, vice-president and treasurer, who has had practical charge of the manufacturing operations from the first, and J. B. Estabrook, secretary.

The company are manufacturers of dynamos and motors that represent the most complete progress in modern science and invention as related to the generation and utilization of the electric current. It was one of the pioneers in the adaptation of its manufactures to the constant voltage system, which by the means of synchronous motors, counteracts the variation in voltage which is the chief source of trouble on lines for the transmission of electric power. The Peerless Electric Company makes a specialty of synchronous electric motors, which represent the most improved form of the constant voltage system. Other specialties are rotary converters and exhaust fans of the most advanced types. The products include electric generators and motors for all branches of electric service. In desk and ceiling fan motors for use on incandescent circuits the company is an acknowledged leader. "Peerless" fan motors have obtained wide fame and a demand that extends all over the United States and to foreign countries, the "Peerless" trademark being everywhere recognized as a synonym for superiority of quality in things electrical. The recognition of this is found in a notable increase in the volume of the company's trade, which has more than doubled in recent years. It has a very complete plant and an able management that has placed it in the forefront of the industry.



FRED P. McBERTY

FRED P. McBERTY

To the management of the Federal Machine & Welder Company of Warren, Ohio, Fred P. McBerty has brought a practical insight into a sequence of manufacturing processes in the development of which he personally participated. These have to do particularly with the building of electric welders, motors, and transformers. In his youth Mr. McBerty was trained to versatility by mastering as a matter of course the several trades then considered essential to an all-round mechanician, and which were also valuable assets to the old-time electricians. He remained in one community and found there the opportunities which he made the stepping stones to a consistently increasing and successful application of his knowledge.

Warren, Ohio, a thriving and beautiful town with an atmosphere peculiar to the Western Reserve, has been the scene of virtually all his activities. Mr. McBerty was born there September 25, 1869, went to its schools, and when eighteen years of age signed on as an apprentice to learn the machinist trade. At the Warren Machine Works his initiation into the business was most thorough, for then blacksmithing, steamfitting and foundry work were an accepted part of a novitiate's training. His second engagement—now as a full-fledged machinist—was with the William Tod Company of Youngstown, Ohio.

Mr. McBerty's entry into the electrical vocation came in 1892 when he secured employment with the Packard Electric Company of Warren, a concern newly organized for the manufacture of incandescent lamps. A year afterward he took a position with another firm organized for the same purpose, the Warren Electric & Specialty Company. Here he had entire charge of all the mechanical equipment used in the production of lamps. These duties depleted his health, to repair which he served aboard the Revenue Cutter "Gresham" in 1897.

Upon his return to Warren in 1898 Mr. McBerty accepted a position with the Warren Electric & Specialty Company, and developed a line of direct current desk fans known as the Peerless fans which proved exceptionally popular and resulted in the sale of many thousands of the particular type. Like success was attained with the Peerless Ceiling Fan, designed in 1899. The next year, while working on the design of an economical desk fan and seeking means to facilitate its production, he built an electric welder to spot weld the fan blades on to the center or spider. At a subsequent demonstration, the first of its kind, the process was proved feasible—in fact, the welder then used is still in good working condition; but, owing to manufacturing conditions, in particular the impossibility of spot welding brass blades to brass centers, the new device was not adopted. The inventor changed the welder slightly by making new electrodes, which causes it to be used for many years after as a butt welder.

The experience just described excited Mr. McBerty's interest and induced further experiment. To W. C. Winfield, of The Winfield Manufacturing Company of Warren, and an inventor with much to his credit, he demonstrated the possibilities of the electric welder. Mr. Winfield followed the idea closely, and the machine was so improved that by 1907 it was introduced as a standard product.

In 1906, Mr. McBerty bought the transformer business of The Peerless Electric Company. He and his partner, Charles R. McCurdy, founded the Peerless Transformer Company, later incorporated as the Enterprise Electric Company. They produced many welding transformers, especially for The Winfield Electric Welding Machine Company.

The enterprise and its inceptors prospered. Mr. McBerty secured sufficient funds and backing in 1910 to enable him to organize a new company for the exclusive production of electric welding machines, the invention which had long been the object of his keenest attention. This was The National Electric Welder Company. He continued the business as such until 1917, when it was bought by the Federal Machine & Welder Company of Warren, for whom he is now manager.

Mr. McBerty is an Associate Member of the American Institute of Electrical Engineers, and he belongs to the Masonic Order.

JOHN WILLIAM LIEB

The place of distinction in the mechanical and electrical engineering branches of science held by John William Lieb, vice-president of the New York Edison Company, was reached through rendering of notable service in pioneering construction. By the nature of his talents he assumes a prominent rôle in the direction of the public utilities which he helped to create. Added to his present post in the New York Edison Company are other responsibilities entailed by his connection with the Edison Light & Power Installation Company as vice-president and director, the presidency of the Electrical Testing Laboratories, as director in the Empire City Subway Company, and as Secretary and director in the Yonkers Electric Light & Power Company.

Four of the leading societies of engineering and electrical men have honored him by designation to the leadership of their

organizations. He is a past president of the American Institute of Electrical Engineers, the National Electric Light Association, the New York Electrical Society, and the Association of Edison Illuminating Companies. He is vice-president of the American Society of Mechanical Engineers, a member of the American Society of Civil Engineers, the American Association for the Advancement of Science, the American Association for the Promotion of Industrial Education, the Franklin Institute of Philadelphia, and the Engineers' Club of New York. He was recently elected president of that unique organization, the Edison Pioneers.

Mr. Lieb was graduated from the Stevens Institute of Technology in 1880 with the degree of Mechanical Engineer. He was then twenty, having been born at Newark, N. J., February 12, 1860. From a draughtsman's board with the Brush Electric Company of Cleveland, Ohio, he went to the old Edison Electric Light Company of New York.

When the famous old Pearl Street Edison Station, the country's first power center supplying current to consumers by the underground system, was being equipped, Mr. Lieb was appointed assistant to the chief engineer. He took charge of installation and participated in the tests of the "Jumbo" dynamo, the pioneer direct-connected machine for electric lighting. The station was opened for service September 4, 1882, with Mr. Lieb acting as first electrician.

In the ensuing years Mr. Lieb performed service of note abroad. He was appointed to direct the installation of a central station with underground system in Milan, Italy, one of the first and best equipped to be operated in Europe. While engaged with the Italian Edison Company he was the technical director who supervised the introduction of the alternating-current system of distribution and the Thomson-Houston arc-lighting system in the principal cities of Italy. Among his rewards were the conferring upon him of the decoration of the Order of Knight Commander of the Order of the Crown of Italy, after his return home.

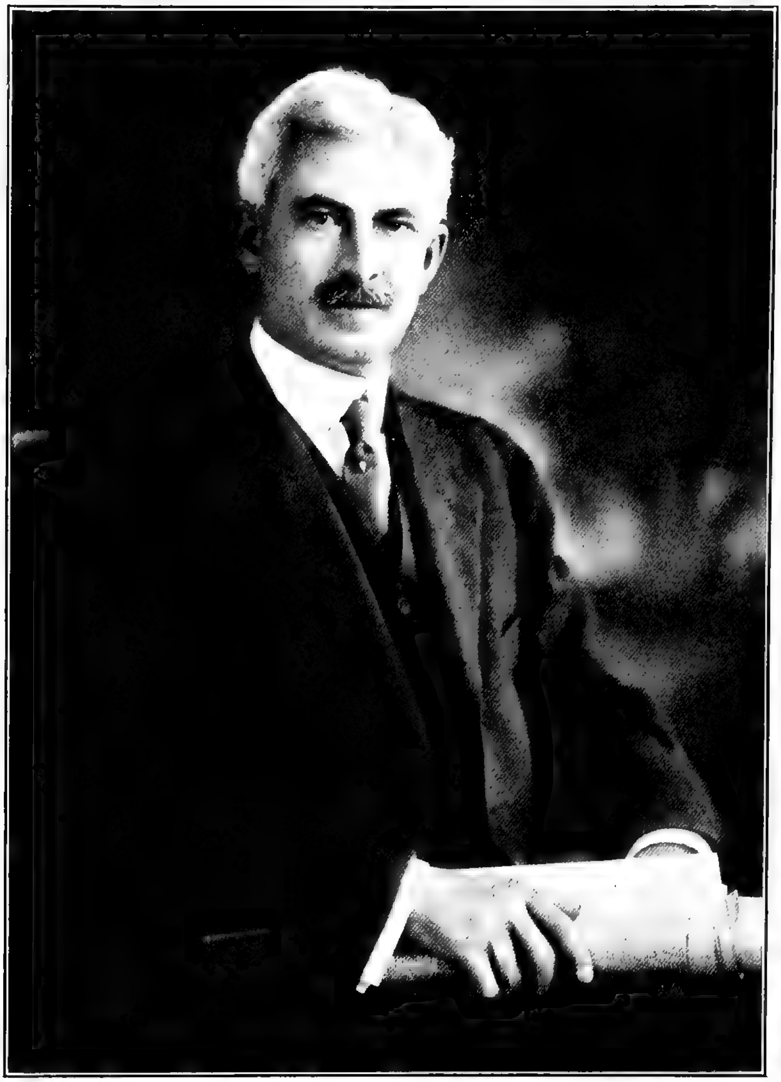
Mr. Lieb returned to New York in 1894, immediately becoming assistant to the first vice-president of the Edison Electric Illuminating Company. Several promotions brought him to be third vice-president and general manager of the company. Since the consolidation of the New York Lighting Companies under the name of the New York Edison Company, Mr. Lieb has continued to take a prominent share in the important problems of administration.

FREDERICK J. PLATT

Many and varied are the fields in which the electrical engineer has brought progress and wrought revolution in industrial methods. "Electrically equipped" means that the most advanced methods have been and are in use in the industries to which that statement can be applied, and this is especially true in reference to the electrical equipment of coal mines, slate quarries and other soft rock excavation work, in which great advance has been made.

Of those who by expert work applied in that direction have added much to the improvement of mining operations and equipment is Frederick J. Platt, electrical and mechanical engineer, of Scranton, Pennsylvania. He was born at Franklin Furnace, New Jersey, July 21, 1871, and after completing his elementary and preparatory education he entered Cornell University, from which he was graduated, after completing the courses in mechanical and electrical engineering, in the Class of 1892. He was made a member of the Kappa Alpha fraternity while in the university.

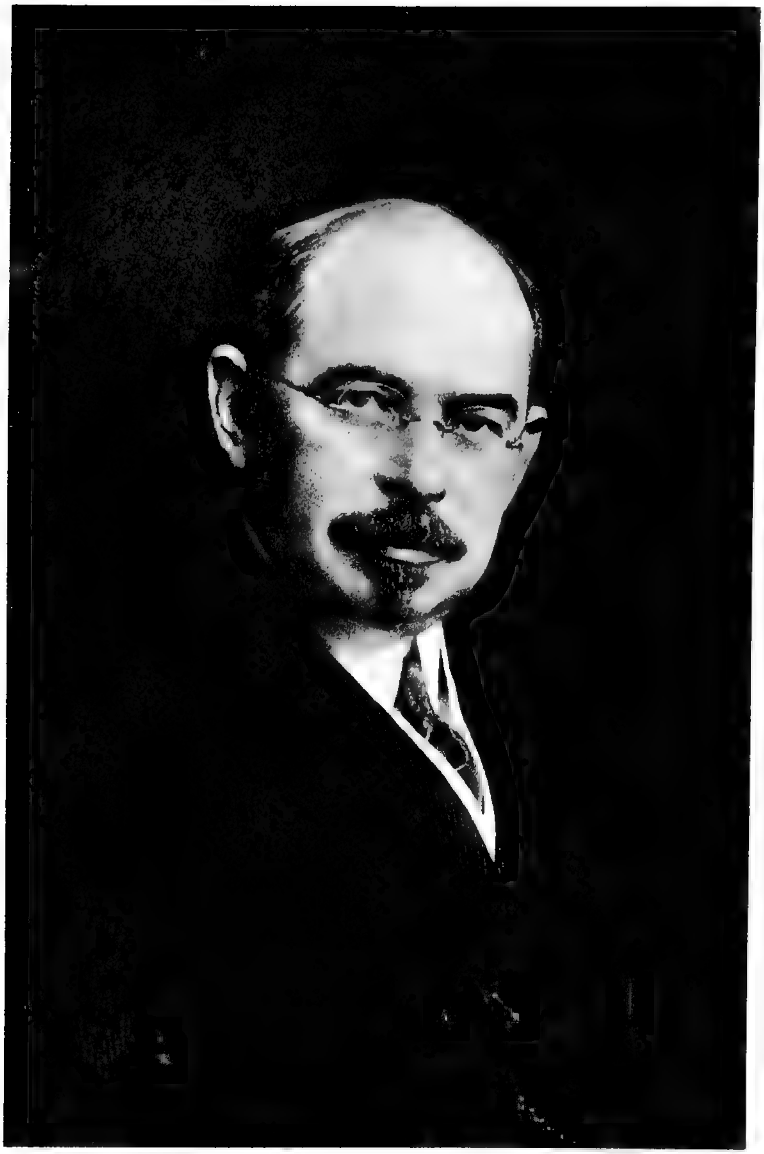
Mr. Platt was connected with Scranton by family ties, his grandfather, J. Curtis Platt, having been one of the founders of that Pennsylvania city about 1846, and it is in Scranton that his entire business life has been passed. He went to the city in September, 1892, and entered the employ of the Wightman Electric Manufacturing Company as electrician of the shop.



FREDERICK J. PLATT

After one year there, he entered and worked about the mines, in order to become intimately acquainted with mining conditions and to discover ways and applications whereby increased efficiency and enlarged production could be obtained by the introduction of electrical equipment. This practical contact with the actualities of anthracite coal mining operations impressed him with the realization of great opportunities for the application of electricity to the mining of anthracite coal. At that time there were only four electric mine locomotives in operation. Mr. Platt, who has ever since been actively identified with electrification of coal mines, has seen the number of electric mine locomotives increase to approximately fifteen hundred in use at the present time.

In 1894 he founded the Scranton Electric Construction Company, of which he is now the president and manager. That company manufactures a rotary electric drill for drilling coal, slate, soft rock, gypsum and rock salt; and also makes switchboards and other devices used about the mines. The company acts as a consulting engineer and does a general electric con-



EDWIN W. RICE, JR.

structing business, making a leading specialty of electric mining apparatus. It acts as agent of the General Electric Company in the anthracite territory of Pennsylvania, installs complete electric light and power plants, and sells a general line of electrical supplies. Mr. Platt is a close student of the progress being constantly made in the methods and devices for the improvement of electrical practice and of new factors and arenas of electric service, and has done much to extend the use of electrical methods in anthracite coal mining.

Besides his position at the head of the Scranton Electric Construction Company, he is president and director of the Keystone Utilities Company; director of the County Savings Bank, the Scranton Trust Company, the Fentress Coal Company and the Scranton Industrial Development Company. He is a member of the Industrial Board of the Scranton Board of Trade, member of the Scranton Club, Scranton Country Club, Kiwanis Club, Madison Country Club of Madison, Conn., and of the Engineers' Society of Northeastern Pennsylvania.

EDWIN WILBUR RICE, JR.

The presidency of the General Electric Company is a position for a great leader —one with breadth of vision and grasp of affairs. The present incumbent, Edwin Wilbur Rice, Jr., is one of the thoroughly versed men in the methods and systems of commercially exploiting the benefits of electricity. His technical knowledge as well as executive ability paved the way for his advance to the head of the General Electric Company. By force of inherent merit his work for this company, with which he has grown up professionally, advanced him from one post to another until the presidency was reached.

Soon after Mr. Rice began the practice of electrical engineering, in 1880, he was appointed superintendent of the Thomson-Houston Electric Company at Lynn, Mass., of which he became technical director in 1884, continuing as such until 1894 or the date of his election to the vice-presidency of the General Electric Company, which had in the meantime absorbed the Thomson-Houston Company. In 1913 he was elected president to succeed Charles A. Coffin, whose official title then became Chairman of the Board of Directors. Expressions of honor have been bestowed upon Mr. Rice on both sides of the Atlantic. He was made a Chevalier of the Legion d'Honneur, as fine a tribute as France could give. He is one of the Pilgrims in London, and a member of the English Institution of Electrical Engineers. He was president of the American Institute of Electrical Engineers, 1917-18.

Edwin Wilbur Rice, Sr.—a widely known editor of religious publications, a Bible scholar and organizer of the Sunday school movement—and Margaret Eliza (Williams) Rice, were the parents of Edwin Wilbur, Jr., who was born at La Crosse, Wisconsin, May 6, 1862. His education was obtained in the Central High School, of Philadelphia, Pa., from which he received the A.B. degree in 1880, and the A.M. degree in 1885. Harvard University conferred an honorary A.M. degree upon him in 1903, and Union College, the Sc.D. degree in 1906.

Mr. Rice married Miss Helen K. Doen, of New Britain, Conn., his first wife, May 28, 1884. His second wife was Miss Alice M. Doen, of New York City, whom he married August 28, 1897. They have a home in Schenectady, N. Y., though much time is spent in New York City owing to the necessity of Mr. Rice's presence in the office of the General Electric Company at 120 Broadway. Mr. Rice is a director of the Electric Bond and Share Company, and a director of the Schenectady Trust Company. He is a member of the Engineers', Bankers' and University clubs of New York, and the University Club of Boston.

WILLIAM D'ARCY RYAN
Director Illuminating Engineering Laboratory, Schenectady
Ex-President Illuminating Engineering Society

RICHARD H. RICE

RICHARD H. RICE

The Lynn, Mass., works of the General Electric Company have been prolific of men and deeds that might cover many pages of electrical history. The post at the head of these works is one of the most consequential within the province of the company. It is now filled by Richard H. Rice, acting manager, who succeeded to the leadership from the position of engineer in the Turbine Department, held from 1903 to 1918.

As may be inferred, Mr. Rice's individual record is distinguished by persistent and successful accomplishment in the interest of his adopted science. Breadth of experience he has also, being a mechanical engineer who has occupied a succession of responsible positions, and an inventor whose fifty-some patents represent practical devices for the subjugation of steam, air and water. Chief among his original creations is the design of the first turbo-blower for blast furnaces to be installed in America, though of foremost value were the Rice & Sargent steam engines, designed jointly with John W. Sargent. These latter were for long the best recognized slow and medium steam engines in this country, and were produced by the Rice & Sargent Engine Company, of Providence, R. I., between 1894 and 1903, when Mr. Rice was secretary and treasurer of that company and the Providence Engineering Works. Since 1903 he has designed the smaller ratings of Curtiss turbines, or those up to 5000 h.p.

Albert Smith Rice and Frances Weston (Baker) Rice were the parents of Richard H. Rice. Ancestors on both sides of the family were early settlers in New England. A paternal grandfather, Richard D. Rice, was president of the Portland & Kennebec Railroad Company, and vice-president of the Northern Pacific under the presidency of Jay Cooke, having been, too, a Justice of the Supreme Court of Maine. A curious reminiscence concerns his having driven a steam automobile of his own invention over Maine roads in 1862.

The education of Richard H. Rice began in the public schools of Rockland, Me., the town where he was born, January 9, 1863. Professional studies were taken up at Stevens Institute of Technology. While there he was a Delta Tau Delta man, graduating with the degree of Mechanical Engineer in 1885. Embarking then in active pursuit of his calling, he served a special apprenticeship in the Dennison shops of the Pittsburgh, Columbus, Cincinnati & St. Louis Railroad from 1885 to 1886, becoming for the year after a draftsman with the Bath Iron Works, of Bath, Me. The next two years were spent in similar work, with the added title of chief draftsman, in the office of E. D. Leavitt, Jr., consulting engineer for the Calumet and Hecla Mines, Cambridgeport, Mass.

By this time Mr. Rice had advanced so far in the development of his profession that he was called to become general superintendent of the William A. Harris Steam Engine Company, of Providence, R. I., in which place he remained from 1889 to 1894, or until he became engaged with the Rice & Sargent Company, entering upon the later period of executive and inventive tasks which have won him a deservedly wide reputation.

Among his present interests is a directorship in the Peerless Truck & Motor Car Company.

Mr. Rice was first married to Miss Mary Sue Durgin, of Concord, N. H., in 1887, who died in 1891, leaving three children, Phyllis, Richard Drury and Sue Durgin Rice. He was married in 1898 to Miss Alice Woodman Kimball, of New York.

Mr. Rice has been closely associated with industrial movements and organizations of a professional nature. For the first two years of its existence he was president of the Associated Industries of Massachusetts, and he is president of the National Conference of State Manufacturers' Associations. The American Society of Mechanical Engineers counts him a member and the Providence Association of Mechanical Engineers, an honorary member.

Mr. Rice is also a member of the University Club, New York; the Mohawk Club, Schenectady, N. Y.; the Tedesco Country Club and the Neighborhood Club of Swampscott, Mass., and the Appalachian Mountain Club.

CUTLER-HAMMER MANUFACTURING COMPANY

Back in the days when thousands marveled at the electric lighting exhibited at the World's Exposition in Chicago, there was established in that same city a little industry which might have been termed an electric machinist shop in which small amounts of work were done on individual orders. Messrs. Cutler and Hammer were the enterprising and hopeful young men of this company.

Soon after there came a need for resistances, resistance boxes, some to be used with the early types of motors and others including regulating resistance to be used with generators. As a result of the need for such apparatus, another small company was started in Milwaukee, known as the American Rheostat Co. In this company were two men, Mr. F. R. Bacon and Mr. F. L. Pierce, who thought the future of the electrical industry particularly good and decided to stake out their lines in this field. The specific object was to manufacture an overload starting box invented by Louis Gibbs and later improved upon by Mr. Bacon.

After both these small companies had progressed to the point where starters, speed regulators and controllers for elevators, cranes and printing presses were made, a consolidation of the companies was effected in 1898 and an enlarged plant established in Milwaukee.

One of the early evidences of the clear realization of the increased use in motor drive and incidentally the need for controller apparatus, was the use and acquiring of complete rights to the No-Voltage Release which although it had been used on Cutler-Hammer apparatus had really been patented by a Mr. Blades of Detroit.

The new plant occupied a two-story building with about 17,000 sq. ft. of floor space. Within a year however, the business had increased to such an extent that the plant was doubled and this process has been repeated at frequent intervals, until at the present time the plant at Milwaukee occupies not only the entire block bounded by 12th St., St. Paul Ave., 13th St., and the railroad tracks of the Chicago, Milwaukee & St. Paul R. R., but goodly portions of four adjoining blocks.

Other companies became associated with The Cutler-Hammer Mfg. Co. of Milwaukee from time to time: The Iron Clad Resistance Co. was one of these. This company began operating at Westfield, N. J., about the same time that The Cutler-Hammer Company started in Chicago. In the fall of 1900 this company sold out to the Cutler-Hammer interests and the year following all work was transferred to Milwaukee, along with a number of the men. Of the latter, Mr. A. W. Berresford, now Vice-President and General Manager of The Cutler-Hammer Mfg. Co. was among the number.

Three years later the Carpenter Enclosed Resistance Co. of New York was taken over, and in 1907 the Wirt Electric Co. of Philadelphia came in, and in 1910, the Schureman Company of Chicago was moved to Milwaukee and joined the larger interests.

Now after 27 years of designing and manufacturing electrical equipment for the starting, stopping and speed regulation of electric motors, The Cutler-Hammer Company has more available information and authentic data on the subject of the control of motors than probably exists elsewhere in the world. Giving counsel or advice to customers is not new to the company: for many years the engineering and industrial men have been urged to make use of the advice of Cutler-Hammer experts in control matters until as one editor of an electrical publication wrote: "The company (Cutler-Hammer) is today regarded as

the court of last resort on the subject of electrical control and many consulting and practicing electrical engineers, contractors and others who are called on in the course of their work to solve problems involving the use of electric motors and their control have received assistance of value by simply telling what they wished to accomplish and letting the engineers of The Cutler-Hammer Mfg. Co. give them details in the light of their past experience and training."

The apparatus manufactured by The Cutler-Hammer Mfg. Co. now comprises many lines, the most prominent of which are listed below:

Motor starters, speed regulators, controllers — Manually and automatically operated types, for every kind of application of direct current and alternating current type motors, Theater dimmers, Battery charging equipment for Trucks, Mine and Industrial Locomotives, Battery charging racks for miners' storage battery lamps, Lifting Magnets, Magnetic Clutches, Magnetic Separator Pulleys, Magnetic Brakes, Motor-Operated Brakes, Dean Motor-Operated Valve Control, Wiring devices and push button specialties: including sockets, pendent, snap, pull, door, automobile switches, etc.; Molded insulation material—thermoplax and pyroplax; Thomas Meter for measuring gases and air in gas plants, steel plants, coke oven plants, etc.; Industrial heating apparatus, linotype and other metal pot heaters, space heaters, soldering irons; Domestic heating appliances — irons, toasters, table stoves, room heaters, milk warmers, etc.

The clutch department has a line of heavier products including lifting magnets up to the standard 62-inch circular type, magnetic clutches and clutch-brakes, magnetic separator pulleys, motor-operated and magnet-operated brakes. Cutler-Hammer lifting magnets are known particularly for their large lifting capacities and their ability to withstand extremely severe service as evidenced by a number of remarkable recoveries of sunken cargoes of pig iron, wire nails, barbed wire and other material.

The push-button specialties department was established 11 years ago, late in 1908. The late Mr. C. J. Klein, who was associated in the early days of the incandescent lamp with Edison and Bergman, brought a little movement to Milwaukee which has been the basis of the line. A further development of this known as the "Hill and Valley" movement is used at the present time in the well-known C-H Seventy-Fifty Switch and other products of this department.

The insulation department has been in existence nine years and besides making the insulating material used in Cutler-Hammer switches and attachment plugs and arc shields for magnetic switches on control apparatus, makes a varied line of pieces such as marine fittings, automobile radiator caps, fuses, housings and boxes, motor and generator terminal blocks, bases for electric grills, heater connectors, etc.

The heating department was established in the same year and it is significant that the man who invented and made the first electric iron, Mr. C. E. Carpenter—thirty-one years ago—is now with the Cutler-Hammer Company. Both industrial and domestic lines of heating appliances are made in this department which is housed in the New York Works, 144th St. and Southern Boulevard.

Of the industrial products in greatest use are the metal melting pots, an example of which is the pot used on the electrically-heated Mergenthaler linotype machine. The standardized two-foot space heater unit has the most varied use.

The Thomas Meter Department makes electrically operated meters for measuring gases and air. These meters are used in city coal, gas and water gas plants for measuring the gas made and distributed. They are also used for measuring natural gas; surplus and full gas in coke oven plants; gas supplied to soaking pits, boiler house and open hearth furnaces. For air measurements they are adapted for metering air to batteries of coke ovens and to blast furnaces, in the latter case with a view to increasing uniformity of output and decreasing production cost of steel.

The officers of the company are: Mr.

Frank R. Bacon, President; Mr. F. L. Pierce, Treasurer; Mr. A. W. Berresford, Vice-President and General Manager; Mr. T. E. Barnum, Secretary and Chief Engineer.

FRANK R. BACON

Mr. Frank R. Bacon, president of the Cutler-Hammer Mfg. Co. was born in Milwaukee, Sept. 28th, 1872. His ancestors were New Englanders of English origin. They were active in both the Revolutionary and Civil Wars. Mr. Bacon attended Princeton University, class of '95, but did not complete his course, entering the grain business with his father in Milwaukee the latter part of 1892. He later became interested in the electrical business owing to a decided taste for manufacturing pursuits. His early work in this field is referred to in another section of this sketch.

FRANK R. BACON

Mr. Bacon has been connected with the electrical industry ever since the forming of the American Rheostat Company and its subsequent amalgamation with The Cutler-Hammer Mfg. Co. Aside from being president of this company, Mr. Bacon has also found time to act as vice-president of the Lackawanna Bridge Co.; secretary of the Worden-Allen Co.; vice-president, E. P. Bacon Co.; director of the Bucyrus Co., and vice-president and treasurer of the Niagara Smelting Corporation.

In October, 1917, he entered the government service, working in the Engineering and Production Divisions of the Ordnance Department, and in August, 1918, was appointed assistant ordnance chief for the Chicago district. After the signing of the armistice, he was appointed a member of the Chicago District Claims Board for settlement of ordnance contracts.

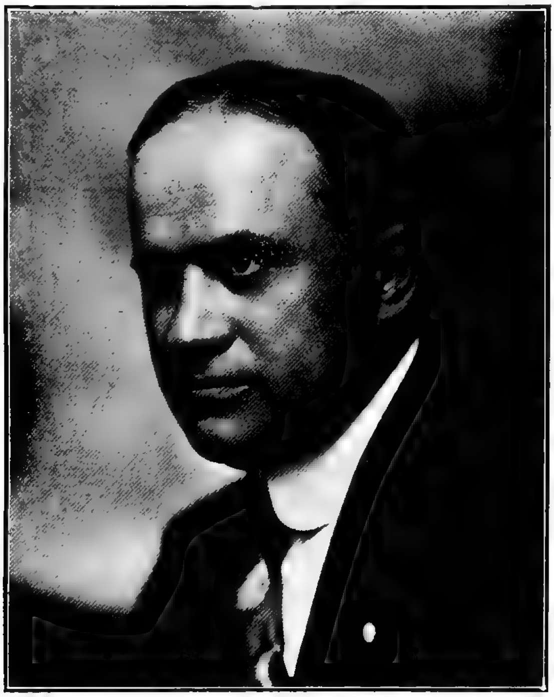
Mr. Bacon is a member of the following organizations: Milwaukee Club, Milwaukee Country Club, Fox Point Country Club, University Club of Milwaukee, Engineers' Club of New York, University Club of Washington, Milwaukee Town Club, Milwaukee Gun Club, Chevy Chase of Maryland, Society of Automotive Engineers, American Institute of Electrical Engineers, and the Caw Caw Shooting Club.

ARTHUR W. BERRESFORD

Mr. A. W. Berresford, vice-president of The Cutler-Hammer Company was born in Brooklyn, N. Y., July 9, 1872, and graduated from the Brooklyn Polytechnic Institute in 1892 with the degree of B.S. and from the Cornell University the following year with the degree of M.E.

Shortly after graduation he entered the employ of the Brooklyn City Railroad Co. and was later connected as engineer with the Ward-Leonard Co. of Bronxville, N. Y. He then became vice-president and manager of the Iron Clad Resistance Co. of Westfield, N. J., and with others of this company joined the Cutler-Hammer organization in 1900. During that and the following years he was the engineer for the company, then became superintendent and in 1906 was made general manager and elected to the vice-presidency.

As evidenced by his early work in the electrical field, he has always had the utmost confidence in the electrical industry. He is a fellow of the American Institute of Electrical Engineers; is a past vice-president and manager of this Institute; member of the American Society of Mechanical Engineers; Society of Naval Architects and Marine Engineers; National Electric Light Assn.; president of the Associated Manufacturers of Electrical Supplies; chairman of the Electric Safety Conference; member of the Society for Promotion of Engineering Education; Electrical Manufacturers' Club; Machinery Club of New York; Engineers' Club of New York; Chemists' Club of New York; University Clubs of Milwaukee and Chicago; Town Club, Milwaukee; Country Club, Milwaukee; Milwaukee Club, and the Mohawk Club of Schenectady.



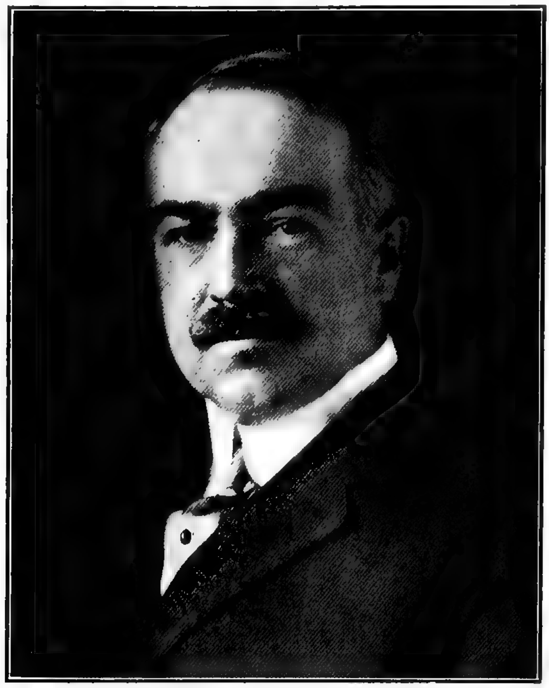
ARTHUR W. BERRESFORD

During the war, Mr. Berresford was Chairman of the General War Service Committee Electrical Manufacturing Industry, and Chairman of the General War Service Committee, Electrical Manufacturers of Electrical Supplies.

CHARLES E. CARPENTER

Mr. Charles E. Carpenter was born in the year 1864 and was educated at Cook Academy, Cornell University (Class of '88), and the University of Minnesota.

In the Fall of 1888, Mr. Carpenter's initial electrical engineering work consisted of the invention of the first electrical flat-iron ever produced and a few months later during the early part of 1889, he organized at Minneapolis, Minn., the first company to manufacture electric heating tools and utensils.



CHARLES E. CARPENTER

In 1900 he invented the well-known enamel type of resistor used in electric heating apparatus and in what are known as Carpenter Enamel rheostats. This type of resistor for heating appliances is still in use and motor control rheostats are also still made in which this type of resistance is employed. Mr. Carpenter was awarded a medal at the Exposition in Chicago in 1893, and the gold medal at the Paris Exposition in 1900.

In 1892 he organized the Carpenter Enamel Rheostat Co. and in 1900 The

Carpenter Enclosed Resistance Co. of New York, which later became a part of The Cutler-Hammer Mfg. Co. Since this time, Mr. Carpenter has been actively engaged particularly in the application of controller apparatus to the printing and publishing industry in which his inventive and engineering abilities have been put to use. About 30 patents have been credited to Mr. Carpenter on electric heating, resistance, and control apparatus.

One of Mr. Carpenter's hobbies is photography and projection work. He is a member of the American Institute of Electrical Engineers, and of the Machinery Club of New York City.

His business address is The Cutler-Hammer Mfg. Co., Times Square Bldg., New York City, and his residence is also in New York City.

FREDERICK L. PIERCE

FREDERICK L. PIERCE

Mr. Frederick L. Pierce, treasurer of the Cutler-Hammer Company, was born in Milwaukee, July 8, 1860, and began his active business career in Milwaukee in the commission business in 1880, becoming interested financially in the American Rheostat Co., with Frank R. Bacon in about the year 1897. This company referred to in the brief history herewith of The Cutler-Hammer Company, later joined with the original Cutler-Hammer Co. of Chicago and the combined organization located in Milwaukee. Mr. Pierce has had charge chiefly of the financial end of the business and was induced to enter the electrical field by the bright future it seemed to present.

Besides being treasurer of the Cutler-Hammer Co., Mr. Pierce is also treasurer and a member of the Executive Committee of the Wisconsin Gun Co., a director of the National Exchange Bank of Milwaukee, a trustee of the Northwestern Mutual Life Insurance Co. and a member of the Executive and Finance Committee of the Northwestern Mutual Life Insurance Company.

Mr. Pierce is a member of the Milwaukee Club, Milwaukee Country Club, The Town Club, The Milwaukee Athletic Club, and the Chenequa Country Club.

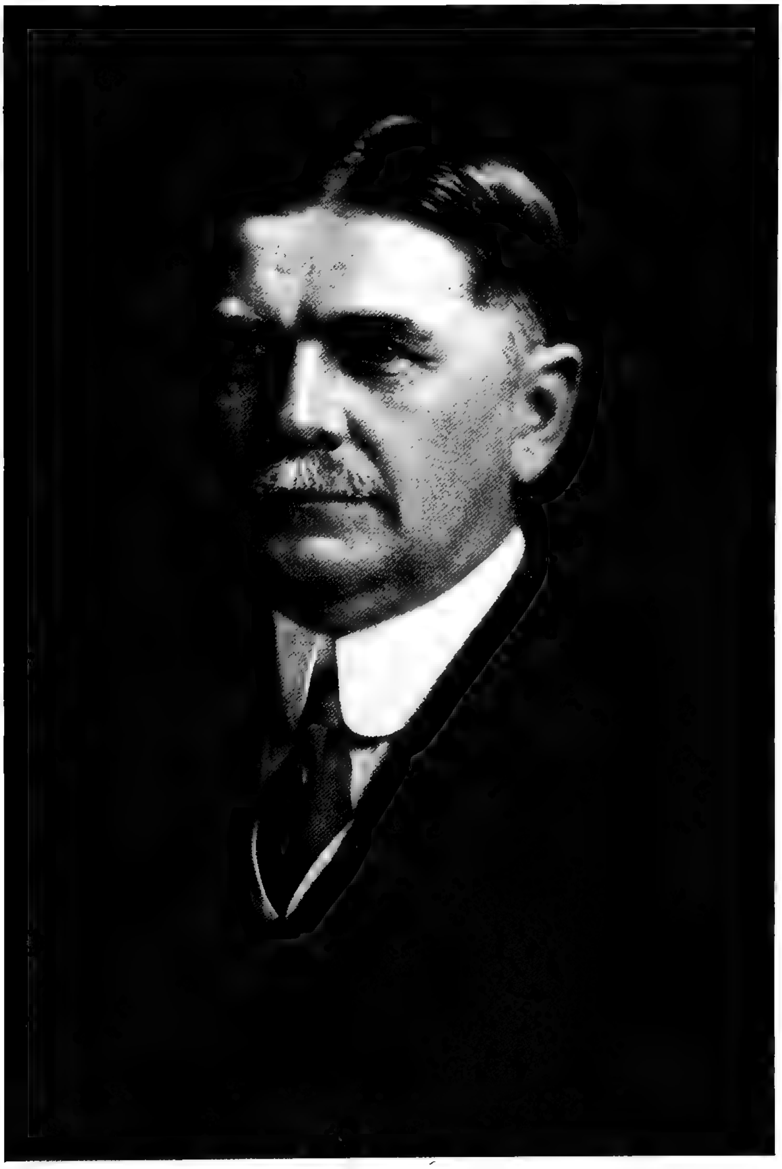
During the war, Mr. Pierce was a member of the local Liberty Bond and Red Cross Campaign Committees.

J. K. ROBINSON

J. K. ROBINSON

J. K. Robinson whose untimely death occurred in September, 1917, was perhaps the best known American in the electrical exporting field. The following obituary notice, published in the *Electrical World,* is a brief résumé of a most energetic life:

"J. K. Robinson, the Chilean representative of the Westinghouse Electric Export Company, died at his summer home, Naples, Me., on Sept. 7, 1917. Mr. Robinson was born in Chicago in 1866 and secured his technical education at the Massachusetts Institute of Technology. He then entered the employ of the Thomson-Houston Electric Company, which sent him to Chile on construction work. Soon afterward he decided to go into business for himself, and was appointed representative of the Westinghouse Electric & Manufacturing Company at an exposition in Chile. This was the beginning of a lifetime connection, during which Mr. Robinson became an engineer of wide repute and one of the best-known Americans on the west coast. Mr. Robinson was a fellow of the American Institute of Electrical Engineers and a member of numerous other professional and social organizations in this country and abroad."



CHARLES EZRA SCRIBNER

Charles E. Scribner, for many years chief engineer of the Western Electric Co., Inc., who now acts in a consulting capacity with that corporation, was born in Toledo, Ohio, February 16, 1858, and is a descendant of Benjamin Scribner, the founder of the Scribner family in America. Mr. Scribner attended the Toledo High School and in 1876 entered the employ of the Western Electric Manufacturing Co., Chicago, Illinois. The name of this company was changed in 1882 to the Western Electric Company and in 1915 to the Western Electric Co., Inc. In all, Mr. Scribner has been with the Company for 40 years, and during that long period has taken out between three and four hundred patents and filed between six and seven hundred applications, principally in connection with telephone switchboards. Mr. Scribner, as an

FRANK J. SPRAGUE

inventor, stands third in the electrical field, and for his work was awarded a gold medal at the Paris Exposition in 1901. He is a Fellow of the American Institute of Electrical Engineers, and a member of the Waubanakee Golf, Lake Mansfield Trout, and Engineers' Clubs, the Telephone Pioneers of America, and New York Electrical Society. In connection with the early development of the Roentgen ray apparatus, Mr. Scribner was the first in this country to make an X-ray photograph from which an operation was performed, and his investigations and research work along this line made a substantial contribution to the art.

FRANK JULIAN SPRAGUE

In the roster of men who have been the foremost energizers of electrical invention and industry will be found the name of Frank J. Sprague. The plot and plan of his life is laid upon an uncommonly large scale, encompassing the creation, promotion and organization of varied electrical utilities. After achieving rank and honors rare in the profession, his power of analyzing electrical problems is still resorted to by numerous interests. From his office at 165 Broadway, New York, he acts as consulting engineer for the General Electric Company, the Sprague Electric Company, and the Otis Elevator Company. At the outset, Mr. Sprague was singularly favored with education and experience. His birthplace was Milford, Conn., and the date July 25, 1857. Winning a competitive appointment to the United States Naval Academy, and graduating therefrom in 1877, his orders took him to Chinese waters aboard the U. S. S. Richmond, where he was a witness to incidents of President Grant's Far Eastern tour, which he chronicled for the *Boston Herald*. An opportunity was afforded in 1880 to put his electrical studies and fondness for experimentation to the test at the shops of Stevens Institute and the Brooklyn Navy Yard. Subsequently he made the first attempt to introduce the incandescent electric light in the U. S. Naval Service. In the course of his naval career he was assigned to attend a notable early electrical exposition held at Crystal Palace, Sydenham, England. There he was the only American on the jury of award composed of such eminent scientists as Horace Darwin, Capt. de Abney, Professors Frankland, W. Grylls Adams and Fleeming Jenkin. Mr. Sprague resigned from the Navy to associate himself with Thomas A. Edison, engaging upon improvements relating to electric light distribution systems. A year later he left Mr. Edison to organize, with Mr. E. H. Johnson, the Sprague Electric Railway and Motor Company, and to work out new principles of design in electric motors and electric railways. Their developments in motors were exhibited at the 1884 Philadelphia Electrical Exhibition, created a great sensation, and were afterwards adopted by the parent Edison Electric Light Company for use by its licensed companies. In May, 1887, there was a contract taken for the equipment of the Union Passenger Railway of Richmond, Va., with 80 motors for 40 cars, a complete overhead system and a central power plant. This constituted the first sizable commercial electric road in the world, and consequently had a vitally quickening influence upon electric trolley development. Sprague trolley roads were installed all over the country and abroad, and were soon followed by elevated electric roads. About 1890 the Sprague Company was absorbed by the Edison General Electric Company. Though Mr. Sprague remained for a time as consulting engineer, he eventually specialized upon a new venture, organizing the Sprague Electric Elevator Company, which developed the modern high-speed screw elevator, the automatic screw elevator, the automatic house elevator and the double-motor elevator. The latter was adopted by the Central London Railway in 1892, and later the multiple unit system of train equipment was installed, by personal contract with Mr. Sprague, upon the South

Side Elevated Railway in Chicago. It served as a pioneer and standard for many other underground and elevated roads. His election to the Electric Traction Commission of the New York Central Railway was the beginning of a four year period of activity on the installation of the road's electric system. When the Southern Pacific Company were planning the electrification of the Sierra Nevada Mountain Section of the Sacramento Division Mr. Sprague shared with the officers of the company the preparation of a report upon the possibilities and difficulties involved. Mr. Sprague has been the recipient of very concrete recognition of his achievements in the form of medals awarded at the Philadelphia Exhibition and the Paris Exposition in 1889, the grand prize for electrical developments at the Louisiana Purchase Exposition, the Elliott Cresson Medal of the Franklin Institute and the Edison Gold Medal for eminence in the electric arts. He is a past president of the American Institute of Electrical Engineers and the New York Electrical Society; a member of the American Institute of Consulting Engineers, the American Society of Civil Engineers and the English institutions of civil and electrical engineers; president of the Inventors Guild in 1916; a member of the University, Century, Engineers, Railway and Bankers clubs of New York. He has served upon the U. S. Naval Consulting Board. Mr. Sprague is president of the Sprague Development Corporation and vice-president of the Sprague Safety Control and Signal Corporation.

LEROY P. SAWYER

LEROY P. SAWYER

Necessity being the mother of industry as well as invention, Leroy P. Sawyer adopted the electrical profession on its commercial side because, we assume, he thought it very much worth while. He cut a wide enough swath through the lower ranks to land him in the responsible post of general manager of the Buckeye Electric Division, National Lamp Works of the General Electric Company at Cleveland, Ohio, and as chairman of the sales organization of the National Lamp Works.

According to the vital statistics of Michigan, Mr. Sawyer was born at Schoolcraft on December 26, 1878. By 1899 he was an alumnus of the University of Nebraska. Starting as a clerk with the Western Electric Company at Chicago, he changed to the Sawyer-Man Electric Company as a salesman, but in a year's time became the Minneapolis manager of the Bryan-Marsh Company. Mr. Sawyer has recently taken up special work in the executive department of the National Lamp Works, at Cleveland, relinquishing his position as general manager of the Buckeye Division. He is counted in the Hermit, Roadside and Union clubs of that city and is a member of the American Institute of Electrical Engineers and the Sons of Jove.

LOUIS STEINBERGER

LOUIS STEINBERGER

There is no need to tell electrical men of the vital value or immense importance of proper and perfect insulation. The subject is one that has commanded the attention from the beginning of great inventors and leading electrical engineers. Back indeed to the primitive days of crude experimentation and eager investigation in the art electric, go theories and tests as to conductors and nonconductors; and when modern applications began with telegraphy, the crying need of good insulation manifested itself immediately. It would be pathetic, if it were not often amusing, to read of the desperate attempts of Morse to insulate his lines. He himself could share the Homeric laughter over his great discovery that beeswax might be smeared upon the wires as insulation, and his utter discomfiture when all the bees in New Jersey bivouacked along the circuits for free lunch and made a clean job of this heaven-sent manna. Or when tar was applied to the iron spans, from a bucket, with a big sponge! Such episodes, and the early struggles with glass knobs, rubber cloth, and other material for pole insulators, are an intensely interesting chapter in themselves, which, however, can here be merely suggested. Real insulation, indoors and out, was and is an imperative necessity, and the search for it has been carried on with the intensity of the quest for the North Pole. It has gone through many stages from silk and cotton and gutta percha, up through glass and porcelain and hard rubber, and may safely be said for this age to have found its goal in "Electrose."

In any country but this, Louis Steinberger, the inventor of Electrose insulation, would have enjoyed signal distinction and decoration for his services to the Government, but it has been reward enough that in a time of stress and danger, he could during the late World War render real patriotic service by the use of his inventions and the utilization of his large manufacturing resources. To speak of one department alone, it may be noted that Electrose insulating equipment for various uses, has been installed throughout the range of the American Navy, from the great battleship "Pennsylvania" down the long list of other monster men-of-war, cruisers, destroyers, and the submarines as well. It is also in general use in all the wireless stations established by the Government, as well as by companies and individuals.

Louis Steinberger has already secured some two hundred U. S. patents, and has hundreds of others coming to him, in a field where his inventive genius, and initiative have literally been pitted against the brains of the world; for one of the prizes of progressive chemistry and science has been an insulation that shall rise superior to all tests to break it down in actual use under the tremendous and inconceivable high frequencies and high potentials of Twentieth Century electrical applications. Much of this work, especially the earlier, relates to interior protection or insulation of apparatus and circuits, leading up to the spectacular triumphs in the field of radio-telegraphy. In wireless, as is generally known, the conditions are onerous, the requirements are most exacting, but the Steinberger material based on thorough study and knowledge as to the vagaries of subliminated static and fugitive currents and discharges has proved more than equal to each emergency as it arose, greatly benefitting and stimulating the new art of "making the ether jump." Yet from this extreme, where tenuous currents are lashed into surpassing fury of expression by super-subtle means that crack the whip of lightning over the earth, Louis Steinberger has carried his work to the other extreme, where he grapples boldly with the latest high voltage transmission systems over which thousands of electrical horsepower of energy are sent hundreds of miles. This is piling one achievement on another, and the statement may seem to smack of rank exaggeration; but it is literal fact just the same.

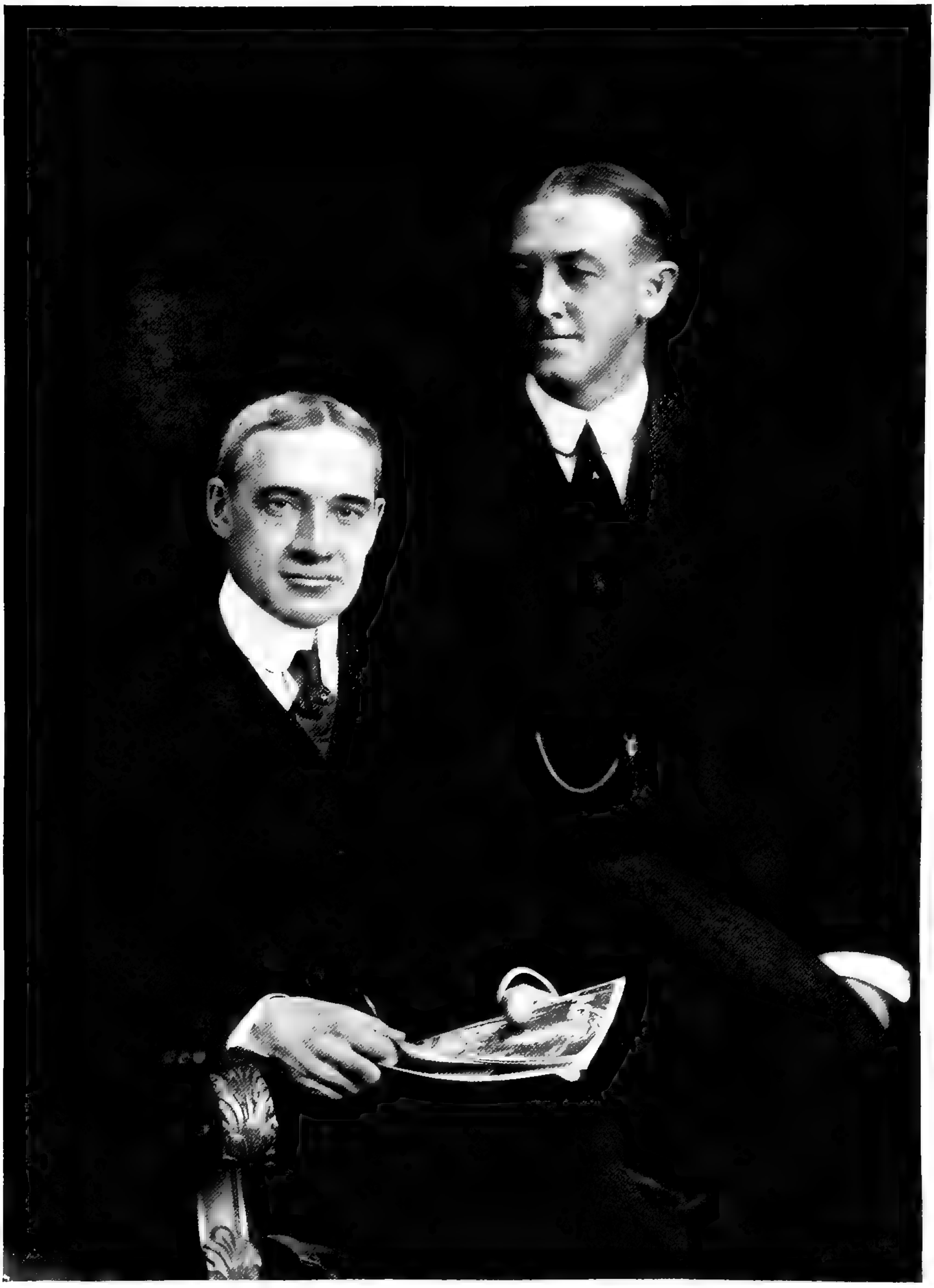
Dating from the historic tests of Creil-Paris, Lauffen-Frankfort, and Niagara, the

industry of power transmission by electricity has advanced with giant strides in a bare 25 years. Thanks to the alternating current, with its huge generators and transformers, deriving energy from either steam or hydro turbines, pressures have gone up to 150,000 volts and the far-flung circuits extend for hundreds of miles. Hence it is now proposed to district all England with only a few—less than a dozen—great sources of electrical supply; practically all California is linked up in one set of transmission circuits; and now the Secretary of the Interior proposes to tie together all the electrical power supply of the North Atlantic Coast. But all this assumes circuits that are and must be properly insulated, and future plans carrying voltages far higher and making the distances greater all depend on having the right insulator. Glass and porcelain still have their place, but Louis Steinberger has given the world the first high-tension insulator of other material, with many gains and advantages. It is based on "Electrose" once more, specially adapted, refined and perfected for the purpose, and now carried far beyond the point of commercial economy and technical success reached when the method and appliances were described very fully in *Scientific American* as far back as May, 1914, when it analysed both "suspension" and "strain" types of insulator, and showed some of them "alive" in operation smothered in snow and ice on blizzard-smitten pole lines. This authority gives due credit to Louis Steinberger as "the first to make successfully and on a commercial basis high potential insulators from a material other than glass or porcelain."

The curious thing is that all this notable, epoch-making work has been done by a man whose training and instincts are of an artistic character, he having studied and practiced portrait, figure and landscape painting successfully in his youth; and a parallel must be found in the fact that the father of American telegraphy was a portrait painter, that Charles J. Van Depoele was a carver of reredoses, that Leo Daft was a photographer, that Thomas Davenport was a blacksmith. But when they turned intuitively to electricity, a career and glory opened up before them all. It is needless to say, however, that in none of the instances thus cited of American inventiveness was the result reached fortuitous or accidental. There were many years of weary toil, painful effort, privation, long vigils of the night, an insistent snatching from Nature of her secrets by those who would not be denied.

Moreover, as in some other distinguished electrical instances, Louis Steinberger, an American in every fibre of his being, is not of native birth, having been born in Hungary. For most of us to be born American has been a matter beyond our choice; here it is a case of deliberate selection, and of a patriotism that burns with white heat. All through our recent participation in the effort to "make the world safe for Democracy," Louis Steinberger was a shining example of lavish generosity toward all the great movements, national and philanthropic, and a constant advocate amongst his numerous employees of participation also on their part. One striking little news item in the *Brooklyn Eagle*—and many others could be quoted—names casually as gifts "to the cause," no fewer than six episodes of public gatherings where he bid or gave outright no less than $6,925, "boosting" in a way that made others respond in kindred measure. Such a man in any community does good beyond computation.

Louis Steinberger is president and general manager of the Electrose Manufacturing Company, which he organized in 1892; he has retained the presidency ever since and has won awards at the Chicago and St. Louis World's Fairs, etc. Through his untiring energy he developed the business to a point where the sales reach the very respectable figure of a million dollars a year—being the largest volume of sales ever attained by any concern in the world making and selling exclusively insulators and insulating parts. He is a member of the Institute of Radio Engineers of the U. S. A., the Navy League, Naval Relief Society, The American National Red Cross, and of many other patriotic and welfare bodies in all of which he takes a personal, active share, playing a man's part with all his vigorous, energetic, buoyant nature.



MESSRS. STONE AND WEBSTER

CHARLES A. STONE EDWIN A. WEBSTER

CHARLES AUGUSTUS STONE AND EDWIN SIBLEY WEBSTER

OF THE

FIRM OF STONE AND WEBSTER

In the electrical field are included some notable men who, combining business acumen and financial experience with technical knowledge, have taken a leading and creative part in the inauguration of great and prosperous electrical enterprises. Of these none is better known than Charles Augustus Stone, of the famous engineering firm of Stone & Webster.

He was born in Newton, Massachusetts, January 16, 1867, was prepared for college in Newton High School, was graduated from the Massachusetts Institute of Technology S.B. with the Class of 1888, and received the honorary degree of A.M. from Harvard University in 1914.

He began his business career with the Thomson-Houston Electric Company, of Lynn, Massachusetts (now the General Electric Company), and from that first glimpse of the opportunities of the electric field became so impressed that he determined to embark upon the business of building and organizing public service plants and corporations, and has since, as member of the firm of Stone & Webster and associated and subsidiary corporations created many electric light and traction companies and built large plants. In addition his firm has done much work in large dam and water-works construction and power plants for the generation and electric transmission of power.

He is now a member of the firm of Stone & Webster; president and director of the American International Corporation, and director of numerous public utilities and other companies.

One of the most treasured associations of Mr. Stone is that which links him to his Alma Mater, and he is a trustee of the Massachusetts Institute of Technology, member of the Executive Committee and a life member of the Corporation. He is a member of the American Society of Mechanical Engineers, American Institute of Electrical Engineers, Union Club, Bankers' Club of America, Boston Chamber of Commerce, Tennis and Racquet, Boston City, St. Botolph, Eastern Yacht, India House, and University clubs of Boston, University Club (New York), and New York Yacht Club.

Edwin Sibley Webster, of that firm, was born in Roxbury, Massachusetts, August 26, 1866. After preparatory studies he entered the Massachusetts Institute of Technology, and was graduated in the Class of 1888. Soon after he entered business life with Kidder, Peabody & Co., bankers, and later joined Mr. Charles A. Stone (his former classmate at the Massachusetts Institute of Technology) in forming the engineering firm of Stone & Webster.

He and his partner were among those who, in the early development of systems of electric light, power and traction service, had the vision to appraise accurately the importance of these developments and the opportunities they presented for judicious and permanent investment. They organized for engineering work of the most advanced efficiency upon the largest scale, secured rights and capital, created electric light and traction systems, built dams, developed water powers, and constructed and installed great plants for the hydraulic generation of electrical current for long distance distribution and use in light, traction and power plants.

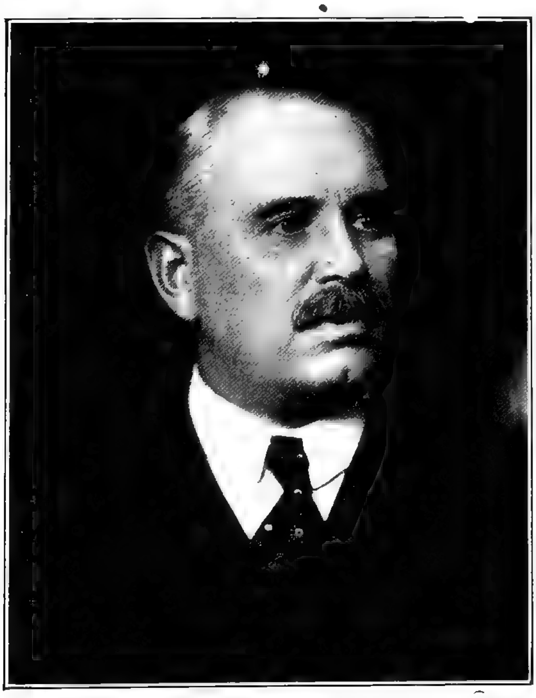
No names are better known in the electrical world than those of Stone & Webster, who have largely created and are now extensively interested in public utility plants all over the country. Mr. Webster, besides his partnership in Stone & Webster, is a director of the American International Corporation, Northern Texas Electric Company, Paducah Traction and Light Company, Pensacola Electric Company, Puget Sound Traction, Light & Power Company, Savannah Electric Company, Tampa Electric Company,

Association, Tampa Electric Company, Blackstone Valley Gas and Electric Company, Cape Breton Electric Company, Ltd., Columbus Electric Company, The Connecticut Power Company, El Paso Electric Company, Fall River Gas Works Company, Galveston-Houston Electric Company, Haverhill Gas Light Company, The Lowell Electric Light Corporation, Mississippi River Power Company, Haskell & Barker Car Company, the Latin American Corporation, and various other companies.

Mr. Webster is a trustee of the Massachusetts Institute of Technology; is a member of the American Institute of Electrical Engineers, of the Union, Exchange, Country, St. Botolph, Boston City, Tennis and Racquet and Eastern Yacht clubs of Boston and the University Club of New York.

H. A. SINCLAIR

Single-minded devotion to the interests of the electrical profession has distinguished the work of Henry A. Sinclair.



HARRY A. SINCLAIR

Many will recall how unstintingly he gave of his time and energy to the affairs of the New York Electrical Society which he served as treasurer for twenty-four years. He is a Fellow of the American Institute of Electrical Engineers and a member of the Illuminating Engineering Society, Brooklyn Engineers Club, Brooklyn Chambers of Commerce, American Geographical Society, American Numismatic Society and the Mechanics Institute. Since 1887, Mr. Sinclair has been continuously active in the business of the Tucker Electrical Construction Company of New York, Cleveland and Montreal, as engineer, secretary and treasurer. Born Sept. 13, 1856, at Springfield, Mass., and gaining his education in that city and Brooklyn, N. Y., his fortunes took a unique turn in 1873 when he was called to the United States Proving Ground at Sandy Hook, N. J. There he became an expert upon the uses of electricity in connection with ordnance, having for ten years entire charge of the electrical apparatus. In 1882 Mr. Sinclair married Miss Nellie W. Grant of Brooklyn. Their one son was born in 1892. Mrs. Sinclair died October 15, 1916.

FREDERICK G. STRONG

The life of Frederick G. Strong early found its outlet in mechanical and electrical pursuits. He came from Portland, Conn., where he was born Mar. 9th, 1868, going for education to Dr. Hollbrook's famous old Briar Cliff Military Academy at Ossining-on-the-Hudson. His first professional connection was with the Mather Electric Company which then, in 1885, was at Hartford, Conn., but later moved to Manchester. Photometry and testing occupied his time. Here, also, he profited by several years of association with Prof. William A. Anthony, who had come from Cornell University. While he was working under Professor Anthony at Manchester, Nikola Tesla appeared, seconded by a mechanician, to test and present his induction motor. A sidelight is thrown on Tesla's ever-ready fund of facetious criticism by his remarks upon examining the minute directions accompanying one of the

old-fashioned direct current motors of the period (about 1886). He said, "I will make a motor that may be given to a Chinaman with these instructions: 'Here you d—— fool, grease the bearings.' " His prophecy fell on unbelieving ears.

Mr. Strong has wandered far afield in the course of his years of resultful service. In Denver, Colo., he acted as chief engineer for the Midland Electric Company and was secretary and chief engineer of the South Denver Electric Lighting Co., and constructing the first station for the Georgetown Light & Power Co. at Georgetown, Colo. The General Electric Company of Yucatan sent him to Progreso, Mexico, where he assumed charge of important electrical construction. Mr. Strong is a Fellow of the American Institute of Electrical Engineers. In recent times he has been engaged in independent practice. His offices and home are in Hartford, Conn., the former at 36 Pearl Street and the latter at 473 Edgewood Street.

The Late General EUGENE GRIFFIN
One of the best known and most respected members of the profession. Long connected with the General Electric Co. as a chief executive officer.

BARZILLAI G. WORTH

During the past quarter of a century new applications of electricity have been a factor in the development of industrial plants. Not only in applications for the propulsion or control of machinery, but as a direct factor in the manufacturing processes themselves, electrical expansion has been marvelous, this being especially true of electrochemical processes.

These electric processes have been evolved by much research and patient experimentation of trained workers, among whom Mr. Barzillai G. Worth of New York is one who has attained results of value.

Mr. Worth, who was born at Tenafly, New Jersey, June 5, 1880, is of old Colonial lineage, descendant of the first American Worth, an English Quaker, who emigrated to Nantucket, Massachusetts, in 1662, and engaged in the whaling business. From his earliest days Mr. Worth exhibited a liking for constructive work, and after completing his elementary and preparatory education he entered the Stevens Institute of Technology at Hoboken, New Jersey, from which he was graduated in the Class of 1901, with the degree of Mechanical Engineer.

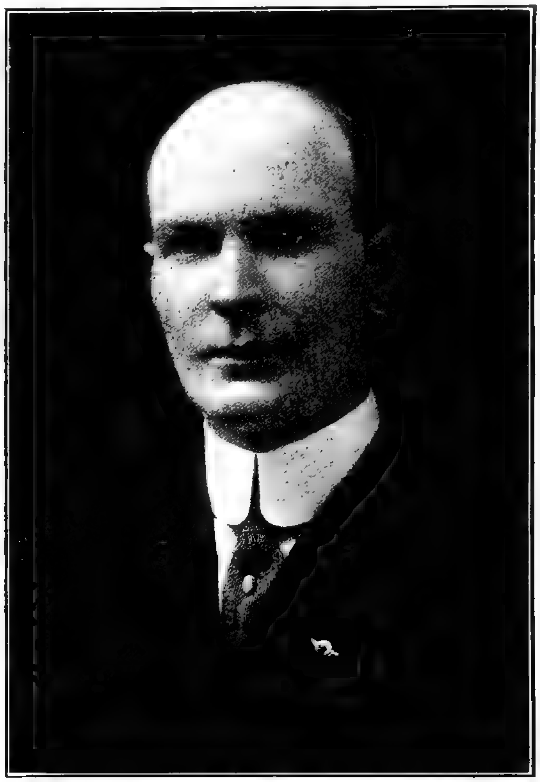
After graduation he entered the office of Walter Kidde, a noted engineer of New York City, and later became electrical engineer of Walter Kidde & Company, Incorporated, of which he is now a director and vice-president. In his connection with that organization Mr. Worth has made various developments in electrical engineering as applied to industrial plants.

Mr. Worth also became connected, several years ago, with the Monmouth Chemical Company, at first in charge of research, but now is a director of the company, having charge both of manufacturing and research. He has accomplished for this company the development of cells and processes for the electrochemical manufacture of chlorate of potash.

He is a fellow of the American Institute of Electrical Engineers, member of the American Society of Mechanical Engineers, the American Electrochemical Society and the New York Electrical Society.

TRUMBULL ELECTRIC MANUFACTURING COMPANY

An interesting story is shown in the origin and development of the Trumbull Electric Manufacturing Company, associated, as it is, with the industrial growth of Plainville, Conn., and which has made that town known in every center where electrical appliances are sold; for the product of the company is such that the names "Trumbull" and "Plainville" are indissolubly linked. The Trumbull Electric Manufacturing Company was organized in October, 1899, by John H. and Henry Trumbull. Each having had practical experience along electric lines, they determined to start in business for themselves, and renting an old, one-story factory they began in a small way to manufacture two-piece rosettes. They employed less than half a dozen workmen, and their struggles to meet the weekly payroll and their present success shows what energy and perseverance will accomplish when confronting seemingly invincible obstacles. The business increased slowly but steadily and another story was added to the old frame building. The company was incorporated after Frank T. Wheeler had joined issues with the Trumbull brothers, the capital being $2,000; which was all held by the owners. In 1905, the company began building the present plant by the erection of a brick extension on the front, which also replaced the original factory. Then a similar building was placed in the rear and later another addition was built running at right angles from the center of the plot. The last construction was in December, 1917. This is a structure running parallel with the first built and joining the center building, forming the letter H. All the buildings conform in design and are three stories with basement and contain three acres of floor space. Soon after the company was organized it began the manufacture of knife switches and afterwards added a large line of wiring devices, including panel boards and switch boards. The most recent addition to the product is a complete line of "safety service," ex-



JOHN H. TRUMBULL
President

ternally-operated knife switches, in which the company specializes. Success has been continuous, the output showing an increase of over 300 percent since 1913, while the number of employees has grown from the first meager force to over 500. The capital is now $500,000 divided into $300,000 common and $200,000 preferred, the latter being held by the officers of the com-

pany—John H. Trumbull, president; Henry Trumbull, treasurer, and Frank T. Wheeler, vice-president. An inventory shows assets of double the amount of capital. The manufactured product reaches

FRANK T. WHEELER
Vice-President

the entire United States and Canada, with a large export trade in Cuba, South America, Spain, Australia and other countries. Offices are maintained and stocks carried at the following places: 114-118 Liberty Street, New York City; 40 South Clinton Street, Chicago, Ill.; 595 Mission Street, San Francisco, Cal. The company also has personal representatives at 76-78 Pearl Street, Boston, Mass.; 1017-19-21 Race Street, Philadelphia, Pa., and agents in Buenos Aires, Rio de Janeiro, Barcelona, and Sydney, New South Wales. S. S. Gwillim is secretary of the corporation, J. C. Regan, general superintendent, and L. L. Brastow, sales manager. John H. Trumbull, president of the company, who is also president of the Plainville Trust Company and director in several corporations, was born March 4, 1873, in Ashford, Conn. He is one of seven sons, all of whom entered the manufacturing business. He was married November 30, 1903, to Maude Pierce Usher of Plainville.

Henry Trumbull, treasurer of the company, was born in Burnside, Conn., January 12, 1875. He was married October 21, 1903, to Nettie Northrup of Bridgeport, Conn.

Frank T. Wheeler, treasurer, was born in Southington, Hartford County, Conn., July 23, 1874. He served an apprenticeship at the machinist trade and is an expert mechanic. He became president of the Trumbull Electric Manufacturing Company in 1899, but resigned in 1910, to become its vice-president. He is an assistant treasurer of the Plainville Trust Com-

HENRY TRUMBULL
Treasurer

pany, and a director of several other corporations and of the Connecticut Automobile Association. He was married June 17, 1903, to Bertha Munson Buell of Southington, Conn.

THE PUBLIC UTILITY HOLDING COMPANY

UNITED GAS & ELECTRIC CORPORATION

Nothing has contributed more to the upbuilding of public utilities throughout the United States than the development of holding companies organized in recent years. Under their management improvements have succeeded each other so rapidly and public service companies have tried so earnestly to meet the public demand for better service that the ten years just passed have marked greater public utility progress than the preceding thirty. The public has learned that holding companies stand for better service, better equipment, and better management, and the companies have won their deserved place in the confidence of the people they serve.

This success is possible because holding companies are managed by leaders in the public utility field, men whose life work has been the expansion and refinement of public service. These men study each step taken by other holding companies. They keep in touch with the developments and trend of public opinion, not only in one community, but in every town and city where public utilities operate. Thus can they adapt to their subsidiaries the best in public utility operation the country over.

For the administration of its subsidiaries the holding company is always on the lookout for high-grade men. Offering as it does chances of advancement not possible in an independent company, the holding company attracts to itself the most progressive and the best trained public utility experts. To a man whose signal success with a street railway or electric company, for example, has benefited some one community, the holding company offers a place where he can apply his talents to a whole group of companies, with a corresponding increase of responsibility and remuneration.

At its central office the holding company employs a staff of specialists who devote themselves to the needs of all subsidiaries. Each man on this corps speaks with authority in his department, as a recognized expert. Thus by maintaining its central engineering department, for example, the holding company places at the service of its smallest subsidiary high-grade engineering experts, such as only the largest and wealthiest independent company could afford.

Central managing, accounting, and legal departments, too, secure to each subsidiary an efficiency otherwise impossible. A central purchasing department effects further savings by standardizing equipment and supplies for all subsidiaries and buying them in large quantities.

Probably the largest public utility holding company is The United Gas & Electric Corporation, which controls properties whose gross earnings in the year ending December 31, 1918, were approximately $35,000,000.

The nucleus of this corporation was formed in 1896, when Bertron & Storrs (now Bertron, Griscom & Co.) bought the Lockport Light, Heat & Power Co. With large property acquisitions in 1900, 1902, 1908 and 1912 came successive changes in the holding company, until in 1912 The United Gas & Electric Corporation was formed. It now controls the following companies:

Birmingham, Ala.—Birmingham Railway, Light & Power Co.—(Street Railways, Gas and Electricity).

Bloomington, Ill.—Union Gas & Electric Co.—(Gas).

Buffalo, N. Y.—International Traction Co. of New Jersey—(Street Railways).

Colorado Springs, Colo.—The Colorado Springs Light, Heat & Power Co.—(Gas, Electricity and Steam Heat).

Columbia, Pa.—Columbia Gas Co.—(Gas).

Elmira, N. Y.—Elmira Water, Light & Railroad Co.—(Street Railways, Gas and Electricity).

Harrisburg, Pa.—Harrisburg Light & Power Co.—(Electricity).

Houston, Tex.—Houston Gas & Fuel Co.—(Gas).

Houston, Tex.—Houston Lighting & Power Co.—(Electricity).

Knoxville, Tenn.—Knoxville Railway & Light Co.—(Street Railways and Electricity).

Lancaster, Pa.—Conestoga Traction Co.—(Street Railways).

Lancaster, Pa.—The Lancaster Gas Light & Fuel Co.—(Gas).

Lancaster, Pa.—Edison Electric Co.—(Electricity).

Lancaster, Pa.—Lancaster Light, Heat & Power Co.

Lockport, N. Y.—Lockport Light, Heat & Power Co.—(Electricity, Gas and Steam Heat).

Leavenworth, Kan.—The Leavenworth Light, Heat & Power Co.—(Gas and Electricity).

Little Rock, Ark.—Little Rock Railway & Electric Co.—(Street Railways, Electricity and Steam Heat).

Memphis, Tenn.—Memphis Street Railway Co.—(Railways).

New Orleans, La.—New Orleans Railway & Light Co.—(Street Railways, Gas and Electricity).

New Orleans, La.—Consumers' Electric Light and Power Co.—(Electricity).

Richmond, Ind.—The Richmond Light, Heat and Power Co.—(Gas).

Terre Haute, Ind.—Citizens' Gas & Fuel Co.—(Gas).

Wilkes-Barre, Pa.—The Wilkes-Barre Co.—(Gas, Electricity and Steam Heat).

The population served by the subsidiaries of the corporation is about 2,600,000. Their railways facilities embrace the equivalent of 1,198 miles of single track; their gas properties embrace 1,420 miles of mains; and the electric generating capacity of their properties totals 228,920 K.W.

THE GREAT WHITE WAY

The first electric illumination of a New York street was attempted Dec. 20, 1880, when a trial was given to the new system of street lighting. With the crude apparatus then in use the result was far from brilliant, and was but a dim forecast of the wonders to be accomplished in the future. As a result of this and other tests it was predicted by many "experts" that electricity could never take the place of gas as an economical and efficient method of lighting streets. Poor as it was, however, the first electric display of street illumination in the American metropolis marked the beginning of the "Great White Way," and the transformation of Broadway by night into a scene of dazzling splendor such as our grandfathers could never have dreamed of. The first display of electric lighting on a large scale was at the Paris Exposition of 1878, when the wonders of the "electric candle" of Paul Jablochkoff, a Russian engineer, startled the world. The Parisian display, however, was dim and dull compared with the marvels since accomplished.

JOSEPH PHINEAS DAVIS

A life like that of Joseph P. Davis leaves grateful memories behind; a sense of indebtedness, and a chronicle of that fertility of human interest which needs must be preserved apart from any material heritage. Large as was the part he played in great engineering projects of his day, there is a background of character and incident illuminating a career which extends beyond professional bounds. We are privileged to present details of his origin, education, travels, and associations, as related by those who knew him best. There comes to us a description of his services while chief engineer of the American Bell Telephone Company, one of the most influential positions which he held, as follows: "Mr. Davis realized at an early date that provision would have to be made in all densely populated centers for placing wires underground. He experimented extensively, seeking in all likely quarters of the globe for information relative to foreign as well as domestic practice in the undergrounding of electrical conductors, and for possible materials suitable for underground construction. He left behind him volumes of data and information thus collected. The detailed manner in which he entered into this study is amazing. As a result of his exhaustive researches and practical experiments he became one of the foremost authorities on this subject of his time."

"When an apparently satisfactory type of conduit was developed (and their number in the early years was legion) we find that he experimented with it not only under all possible conditions that might be encountered in one locality, but in various localities in the United States. Mr. Davis with his keen analytical mind, was able to grasp and to take into consideration the various factors influencing construction. When the agitation for the undergrounding of electrical circuits finally swept over the country he was fully prepared to meet it. All of the subway construction for telephone and telegraph lines throughout the United States, as well as the construction for electric light and power in the City of New York, was at that time personally directed by him."

Joseph P. Davis was born in Northboro, Mass., April 15, 1837, the son of William Eager and Almira (Sherman) Davis. His ancestors were among the early settlers of New England. The Davis predecessor, Captain Dolor Davis, landed in Plymouth in 1634. Later he settled in Concord, Mass. The first man killed at the battle of Concord Bridge was a Davis, doubtless a descendant.

The Northboro home was started in 1773 by the great-grand-father of Mr. Joseph Davis, Deacon Isaac Davis, who went there from Rutland, Mass., and became a successful tanner. The Sherman family were also among the early arrivals in New England, landing in 1634. Captain John Sherman settled in Watertown, Mass. He was a captain of militia, a steward of Harvard College, a surveyor and representative of the general court. William Eager Davis, Mr. Davis' father, died when only thirty-three years of age of "Inflammation of the lungs," after he had been duly bled by the country doctor. He died Christmas day before Mr. Davis was born the following April.

The young widow had three others sons, the oldest seven. She suddenly had the responsibility of a large farm and a share in the tannery business, with apprentices "bound out" in the house. Of inestimable assistance to her was a neighbor, Col. Joseph Davis, for whom Mr. Davis was named. Mr. Davis always spoke of this old gentleman with the greatest pleasure and reverence. Col. Joe was a colonel of militia and annually drilled the volunteer troops. When he, with nine children of his own, wished to marry "the Widow Sherman," the stepmother of Mr. Joseph Davis' mother, she said, "But what will become of my five Sherman step-children?" He promptly replied, "Bring them along, mix them with mine."

John Davis, who was four years governor of Massachusetts and twenty-four years in the United States Senate was a great uncle. He was popularly known as "Honest John." Tradition says that when he was serving on the Ways and Means Committee with Daniel Webster he staunchly refused to sanction some meas-

JOSEPH P. DAVIS
(DECEASED)

ure which he did not consider right. After several days arguing Mr. Webster said: "Gentlemen, we might as well adjourn, you can't move Honest John." Mr. Joseph Davis often spoke of how proud he was of the traditions of honesty and integrity throughout the family. He strongly disapproved of "lobbying" and when companies with which he was associated considered this necessary he was not informed concerning it. He would never allow his name to be put on a bridge of which he was chief engineer. Usually the names of the mayor, board of aldermen, etc., were carefully inscribed, but he considered his work only in the line of duty. He always refused to give a position or recommendation to anybody, "because he went to school with their grandfather." Nothing but known merit won a recommendation from him. He was just and generous always trying to develop original ideas in those working with him. Thus his career was guided by the principals of his stern New England forbears.

Mr. Davis' earliest school days were under "Parson" Joseph Allen, who for fifty-five years ministered to the spiritual needs of the people of Northboro, and who in his Home School started the career of many prominent men in New England in the early part of the century. Later Mr. Davis went to school in Boston. During vacation he was expected to work and accordingly was early placed in a Boston store. Soon stock-taking time came and he was set to measuring the bolts of cloth. Whenever they ran short in measure they were to be marked up to the next yard. Though, but fifteen, his native honesty rebelled and he returned home indignant. This decided him in regard to the future, for he entered Rensselaer Polytechnic Institute in Troy, N. Y., from which he was graduated in 1856, at the age of nineteen. Immediately afterward he was engaged as a rodman at $1.25 a day on the Brooklyn, N. Y., waterworks, later being promoted to the position of transitman at $2 per day. The party had charge of the building of the foundations and the construction of Mt. Prospect reservoir and engine house. Mr. Davis directed the building of engine house No. 2, at Ridgewood and his salary was increased to $60 per month.

In the summer of 1860, hearing that the Peruvian Government wished the services of three American engineers, he made a proposition through the Peruvian Minister for a contract for five years at $4,000 per year, one-half payable in gold. While awaiting a decision the Civil War came on. Mr. Davis was drilling with a Brooklyn regiment when he saw the troops pass through New York on their way South in April, 1861, and noting sectional feeling running high, he went to the Peruvian Minister to withdraw his proposition. To his surprise the Minister drew out a bag containing $2,000 in gold and informed him that he was bound to his contract.

On July 11, 1861, as topographical engineer of Peru, accompanied by Mr. Church and Mr. Backus, he sailed in the steamer Northern Lights for Aspinwall. They made an irregular course to avoid privateers and apparently the living was neither comfortable nor good. There was no ice on board and much of the food spoiled. The same month he sailed for Callao in the steamer Lima, which he described as "an iron paddle, elegantly fitted up and very well arranged. The only reform should be in the table waiters and the cleanliness of the linen." The coast of Peru was most uninteresting. They arrived in Calloa, after paying the exorbitant price of $25 to get their baggage ashore, then proceeded to Lima, where in Mr. Davis' words, they "put up at the best hotel here. Church and myself occupied rooms in the third story. Without carpets, or anything to give them an appearance of comfort, beds with scant covering, a few wooden chairs, a rough table, and a chest of drawers, are the whole furnishing of the room."

The carefully kept journals of the next four years are of the greatest interest, together with copies of reports handed in to the Minister of Public Works, concerning the water supply of towns, plans for bridges, railroads, artesian wells, and repairs to public works. Mr. Davis made designs for an iron bridge across the Piura at Piura, a stone arch bridge across the Ilavian in the department of Puno (spans of 16½ meters each), a number of wire cable bridges (hammock bridges) for

mule traffic, and for a system of sewage in the city of Lima.

Probably the most important piece of work he did while in Peru was to survey the great guano beds of Lobos and the coast north of Lima. This work lasted from October, 1862 to May, 1863. Mr. Davis was head of a commission, to which later belonged Engineer Hindle and assistants Tweedale and Lund. The steamer transport Huarez was sent with them. The captain of the ship refused to give the engineer corps the aid needed and they were delayed by lack of instruments. The islands were not only surveyed, but borings were made to determine the character and depth of the guano. The ship would be gone ten to twelve days to obtain water, and in the meantime the engineers had scarce food, mostly beans, no cook and no tent. The Spanish proclivity to procrastinate, the proverbial "mañana," was a great detriment. It seemed almost impossible to get men started before noon, and whole days were lost because officials could not make up their minds when to move.

Some time was spent in Lima preparing the reports and doing minor work for the city and neighboring towns. The Department of Public Works wished this presentation hastened that Mr. Davis and Mr. Church might go inland, one to the Province of Puno, and the other to Cuzco. There was some trouble with Spain in regard to the Guano Islands at the time, and the general dissatisfaction threatened a revolution. The engineers did not wish to go inland, perhaps suddenly have the treasury seized and their entire source of supply cut off, so they offered to resign, but finally compromised by being allowed to make a tour of the provinces together, making notes in regard to public works on the way. They left on the steamer Bolivia for Islay. There they got pack and saddle animals and proceeded inland to Puno. "At the tambos or rest houses you were furnished with grass or dry straw for the beasts, a chipe, and room upon the earthen floor on which you spread your own bed. The nights were very cold and the rooms exceedingly well ventilated." They saw many herds of llama and vicunas. Near Lake Titicaca the engineers met Mr. E. George Squeir, the antiquarian, with whom they traveled up to Cuzco and down over the Andes to the coast. They surveyed with great care the Inca temples and fortifications and were much interested to find that earlier than Columbus' time these intelligent people had so developed the "arch" that some of their bridges were still usable. They also had some form of drills, for tunnels were found which showed the mark of some such instrument. The party surveyed the wonderful terraces on the mountain sides where the Incas had gardens.

In coming down to Lima they crossed the great hammock-like swinging bridge across the Apurimac, one of the head waters of the Amazon. Mr. Davis says, "as we zigzagged our way into the valley below by a descent of some 3,000 feet, the scenery grew magnificent, and just before reaching the bridge, stupendous. The road enters the Apurimac Valley, which is here a canon with high precipices for sides, by a narrow lateral valley and as you reach the former you are on a level with the water. From the river you ascend to the left by a ledge cut on the face of the rock precipice to the level of the bridge. Here the animals were unloaded and the cargoes taken over on the backs of men."

Mr. Davis and Mr. Church took accurate measurements of the bridge and found it to be 147 feet long and 118 feet above low water. It was constructed of thirteen cables of twisted cabuya or maguey fibres, eleven arranged below the floor and one on each side to form a hand railing. These ropes were strongly tied to timbers anchored in the rocks. The floor consisted of small slippery sticks lashed together and laid across the cables. They had no difficulty in getting animals to cross and experienced none themselves, though a strong wind swayed the bridge some five feet from side to side, and as the cables had sagged, there was a steep inclination toward the middle.

Although the contract with the Peruvian government was for five years, Mr. Davis returned to the United States in July, 1865, receiving a leave of absence, as a revolution was threatening—the revolution was successful and the engineer corps was abolished. Mr. Davis was appointed

assistant engineer to lay a 48 inch main from the Ridgewood Reservoir to Brooklyn. In June, 1866, he was made chief engineer of Prospect Park. In May, 1867, he was offered the position of principal assistant engineer on the St. Louis Water Work, which were about to be constructed. This he accepted, went to St. Louis, and under the direction of T. J. Whitman at once began plans for putting the work under contract.

Early in 1870 he was appointed chief engineer of the Lowell, Mass., water commissioners, who had recently been chosen to build a new system of water supply for that city. He designed and placed under contract the new supply. In November, 1871, he received the appointment as chief engineer of the Boston, Mass., water board. He accepted the position, agreeing to give part of his time to Lowell. He resigned in May, 1872, and in December was made chief engineer of the city of Boston, which post he held until March, 1880, when he became chief engineer of the Telephone Company.

While acting as chief engineer of the Boston Water Board in 1871 and 1872, he made an oral report to the Board recommending the Sudbury River as an additional supply. During his term the works to bring that supply to the city were designed and constructed, also an improved system of sewage was made and placed under contract. In preparation for this improved sewage, the city granted Mr. Davis four months' leave of absence and 1,000 pounds sterling for expenses. For his investigations he visited England, Holland and Germany. The results were something quite new in this country.

In 1880 Mr. Davis became chief engineer of the American Bell Telephone Company and its successor, the American Telephone & Telegraph Company. He was appointed a member of the executive committee and elected vice-president, which position he held until 1886, when he resigned his positions on account of ill health. The territory of the company covered a circle of thirty-three miles radius, centered at City Hall and including all of Long Island and Monmouth County, New Jersey. As the president of the company resided in Boston and took little part in its management, Mr. Davis performed the local administrative duties of the president as well as general manager.

In 1885 Mayor O'Brien, of Boston, asked him to become consulting engineer of the Commission appointed to consider high service water supply for that city. From 1886 to 1904 he was consulting engineer of the Metropolitan Water & Sewage Board, of Massachusetts. In April, 1884, he was made consulting engineer to the New York Aqueduct Commission. In accepting his resignation in 1886, on account of ill health, the commissioners "wish to express their high appreciation of your professional skill and attainments and the very valuable service you have rendered to this commission." After returning from a trip to Europe he was appointed an expert in March, 1888, by the Aqueduct Commission to consider the plans of the Quaker Bridge Dam.

In July, 1887, Mr. Davis was appointed consulting engineer of the Metropolitan Telephone & Telegraph Company. The same year he was appointed consulting engineer of the Consolidated Telegraph & Electrical Subway Company, also of the Phœnix Construction Company. In 1887 Mr. Davis was chosen an expert to assist the city engineer of Milwaukee. He also served as an expert for the city of Providence. He was president of the Hudson River Telephone Company, from 1889 to 1895, and the Westchester Company, from 1890 to 1893.

For some time Mr. Davis' eye sight had been failing. He used to say that much of his work was done at night, often toward the early morning hours, and frequently the artificial lights were very poor. In January, 1903, the worst eye was operated on for cataract, satisfactorily from a surgical standpoint, but the eye was found to be congenitally abnormal, only a small portion of the retina ever having been sensitive to light. The disappointment was great, but he kept at work as long as possible and in 1903 he was a director in the following companies: Metropolitan Telephone & Telegraph Co.; New York Telephone Co.; Hudson River Telephone Co.; Westchester Telephone Co.; Union Telephone Co.; Northern New York Telephone Co.; Hudson River Telephone Co.

of Penn.; American Telegraph & Telephone Co.; N. Y. & N. J. Telephone Co.; N. Y. & Penn. Telephone & Telegraph Co.; Empire City Subway Company; Chesepeake & Potomac Telephone Company; Southern Bell Telephone & Telegraph Co.; Bell Telephone Company of Buffalo; Central District and Printing Telegraph Company; and Chicago Telephone Co.

Convinced that he could do no more useful work, Mr. Davis began to resign his positions. In February, 1909, Mr. Vail wrote "Your letters of resignation received. As you seem to be insistent that they should be accepted, we have accepted them this day, but it is with much regret that we do so. I had intended to let it lay, but upon my return I find that you have returned your check for the January salary. I should be pleased if you would reconsider your action and continue here, at least for the present, under the old arrangement. This is the wish of all connected with our company." Mr. Davis was obdurate for he never believed that any man should retain a salary or position as an honorarium.

Many a young man has Mr. Davis to thank for the commencement of his education. He would have resented being considered socialistic in his tendencies, but thirty years ago he told a friend that he considered that every man who did not marry and have children of his own to educate had a duty to the State. In order to fulfil that duty he should help other men to educate their children and thus make useful citizens. A very large portion of his income went for educational purposes, not only among private individuals but also to institutions. This was never done with any sense of it being a charity. He was a man of very deep religious principles, though he never went to church. He said that he would enjoy going if the prayers were omitted. He could not help feeling that such dictation to the Almighty was insulting. His early training was in the Unitarian Church, and Sunday was then a day of ordeals.

Mr. Davis was a director and vice president of the American Society of Civil Engineers; a member of the Society of Telegraphic Engineers and Electricians of England, American Institute of Electrical Engineers, Society of Mechanical Engineers, and the Boston Society of Civil Engineers. His greatest pleasures were the fishing trips in the summer, when with a chosen few "Bostonians" he camped and angled for the wily trout and ounaniche. In 1883 he became a member of the Century Club, and for many years the old friends met together there.

In social matters Mr. Davis was a very timid man but he thoroughly enjoyed companionship, and the letters which came to him from men who had formerly worked with him. Perhaps many years after they had met with success they would realize how much they had gleaned from him and write to him accordingly. He felt more grateful for those letters than for praise of his own engineering achievements. He died as he had lived, everything well ordered and methodical. His check book balanced in the morning, he took a walk in the afternoon, became unconscious while preparing himself for dinner, and died the next night, March 31, 1917. He was buried in Northboro, the town which still retained his affection and whose welfare he remembered in his will.

MILAN R BUMP

MILAN R. BUMP

An intimate connection of several years with the public utilities represented by Henry L. Doherty & Company has been the medium through which Milan R. Bump has become known for his work in electrical engineering. Beginning in 1904 as field engineer and, from 1910 to date, as chief engineer of that organization, his position has entailed supervision over the operations of thirty-eight public utility companies controlled by the Cities Service Company as well as the general engineering direction of other activities of the same company. The one interruption in the continuity of Mr. Bump's service with the Doherty interests occurred in 1915, during which year he was vice-president of the Picher Lead Company of Joplin, Missouri.

Throughout his experience Mr. Bump has been influenced by faith in the great future possibilities of the public utility field, believing that the most satisfactory development must come through a closer mutual understanding between the companies and their customers. Further, his conception of the ideal relationship is one that would make every customer a security holder.

Mr. Bump was born at Rock Falls, Wisconsin, on March 18, 1881. He received his common schooling in Spokane, Washington, but for higher education he returned to Wisconsin to enter the State University. He was a member of the Tau Beta Pi the honorary engineering fraternity, graduating in 1902 with the B.S.E.E. degree. Going west, he joined the Washington Water Power Company of Spokane as an engineer on the design and construction of that company's first 60,000 volt transmission lines connecting Spokane with the Coeur d'Alene mining district.

Mr. Bump is a member of the Executive Committee and 2nd vice-president of the National Electric Light Association, having also been chairman of the Hydro-electric and Technical Section. In the American Institute of Electrical Engineers he has been an Associate since 1902. He holds membership in the Engineers' Club of New York, the Toledo Club of Toledo, Ohio, and the Reform Club of New York, in which he is a member of the Board of Trustees.

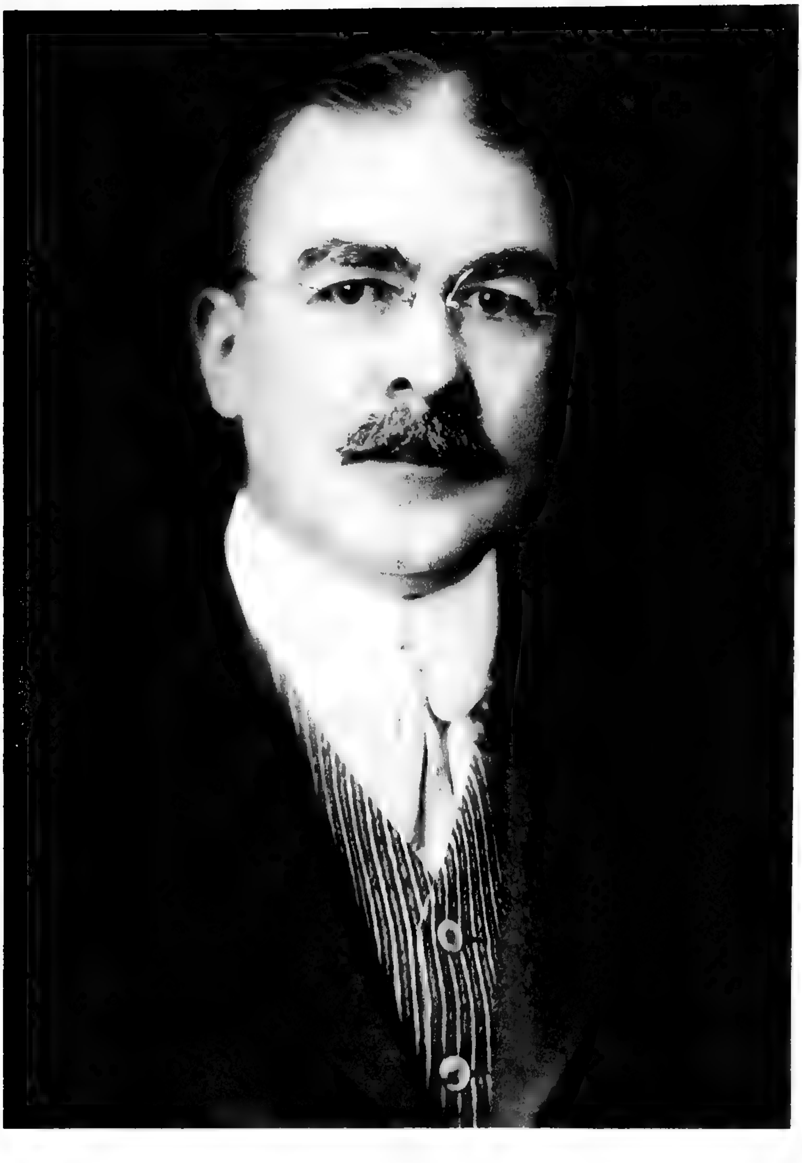
Mr. Bump makes his home at Montclair, New Jersey. His business address is 60 Wall Street, New York.

MARIANO L. MORA

Mora & Mendoza conducts a business of influence in the export of machinery for the sugar industry of the West Indies. The firm's principal connection is with the Victor G. Mendoza Company of Havana, Cuba. The New York house has in Mariano L. Mora, an electrical engineer whose experience fits him to deal with the specialized electrical questions pertaining to their machines. He is also vice-president of the Victor G. Mendoza Company of Havana, and the Mora-Oña Trading Company of Sagua, Cuba.

Mr. Mora was born at Sagua la Grande, Cuba, on February 28, 1869. He was graduated from the Columbia University School of Mines in 1891 as a civil engineer and again in 1894 as an electrical engineer. Mr. Mora spent sixteen years in the service of the General Electric Co.

He is an Associate of the American Institute of Electrical Engineers; a member of the India House, New York; the Gedney Farm Country Club, White Plains, N. Y.; the Mohawk Club, Schenectady, N. Y., and the Havana Yacht Club.



ARMISTEAD K. BAYLOR

ARMISTEAD K. BAYLOR

Many tasks of consequence in administrative electrical work have fallen to the lot of Armistead K. Baylor, one of the General Electric Company's experienced executives. During the greater part of the last thirty years he has devoted his services to this company or its allied enterprises.

Of recent consideration are his activities dating from 1911 when, returning from a sojourn abroad, he assumed managerial duties in connection with the business of public utility holding companies at the general offices of the General Electric Company, New York City, being also active from time to time on various special assignments. The department of heating devices was under his supervision from December, 1914, to January, 1918, or until the date when it was transferred to the control of the Edison Electric Appliance Company. An appointment of both honor and responsibility was given Mr. Baylor in September, 1918, by the General Electric Company, which made him special representative in charge of its Government work at Washington. To complete the undertaking involved, he remained at that post until June, 1919.

By ancestry Mr. Baylor comes of a family originally English, but the branch to which he belongs has traditions going back to 1735 when John Baylor, a paternal ancestor, settled in Newmarket, Virginia. A number of the latter's descendants served in the Revolutionary War, one having been an aide on the staff of General Washington. Armistead K. Baylor was born April 11th, 1868, near New York City. Technological subjects, especially the nascent arts of electricity, had the strongest appeal for him from earliest years. Studies pertaining thereto were pursued in preparatory schools only to be interrupted after two or three years by his going into business in Boston.

The defection from his chosen calling was of brief duration, however, for in 1891 he found an open avenue to the exercise of his talents at the Lynn, Mass., plant of the Thomson-Houston Company. Upon completing the prescribed service he entered the construction department. Returning to Lynn after a year's absence he became a special assistant to Walter H. Knight. In that capacity he acted as engineering representative for the factory on railway work, and while so engaged observed the demonstrations and followed the operation of the novel types of motors and controllers then being introduced. Incidental assistance given to the salesman led him directly into the sales department. He went to Schenectady, N. Y., in 1894 when the headquarters of the newly organized General Electric Company were established there. Again, in the same year, he moved to New York City, to become the New York assistant of W. J. Clark, manager of the railway department, with whom he was associated until May, 1896.

The last date marks a point of departure in Mr. Baylor's professional record. His engagements in America were laid aside to go to London. In the English capital he joined the British Thomson-Houston Company as manager of the traction department, and to these responsibilities were added those of general sales manager. For several years, from 1901, when his labors with the Thomson-Houston Company were brought to a conclusion, Mr. Baylor remained in England in private practice as a consulting engineer.

As already related, since his return to America he has been identified with the business of the General Electric Company, at its general offices in New York. He is a vice-president, director, and member of the executive committete of the Edison Electric Appliance Company, and a director of the Electric Vacuum Cleaner Company.

A pursuit of spare hours which has claimed the interest of Mr. Baylor is the study of the educational and industrial uses of motion pictures, an art whose commercial possibilities are just beginning to be realized. Mr. Baylor's social and club affiliations are many. On the electrical side they include the American Institute of Electrical Engineers, and the Institution of Electrical Engineers of London. He is also a member of the Engineers', Lotos, Bankers', Engineers' Country Club, Richmond County Country Club of N. Y., and the Mohawk and Mohawk Golf Clubs of Schenectady.

MORTIMER B. FOSTER

The electrical engineer has in some circumstances been driven to invention by the architect and builder. Architects evolve ambitious plans, precedents of construction are broken right and left, and new and radical departments must be made in the hitherto settled methods of erecting a complete building. The word, comolete, means here an harmonious whole composed of co-ordinate units, each demanding a separate activity. A modern office building holding a daily population of several hundred, or even several thousand people has its vital parts like some great trans-Atlantic liner; functions through its system of heating, lighting, ventilation, and transportation. New York's lofty skyscrapers created a host of new construction problems to test the mettle of experts, and the task of the electrical engineer was not the least difficult.

The engineering profession as pursued by Mortimer B. Foster has covered more than one specialized branch of practice, but an interesting feature of his career is the number and variety of buildings the electrical equipment of which he has planned. The Singer Building, New York, is a noteworthy example. As might be inferred, there were new calculations to be made and original methods to be devised for carrying them out. The exterior illumination of the tower called for an ingenious arrangement of lights, which was the subject of extended experiment. A few of the other buildings which Mr. Foster equipped electrically were, the American Bank Note Building, New York; the new West Point Buildings, the Boston Opera House; the Morgan Memorial Building at Hartford, Conn.; and the Municipal Buildings at Springfield, Mass., St. Louis and other cities, as well as textile and paper mills in New England.

Mr. Foster is a New Yorker, born October 26, 1878. He received the excellent education given student engineers by the Massachusetts Institute of Technology, graduating with degrees in the class of 1901. Then followed practical training in electrical construction in the employ of P. L. Hoag of New York City.

From the fall of 1902 until the completion of the Singer Building, Mr. Foster practiced independently. Through later years he has chiefly devoted his time to a variety of commissions undertaken by the Shield Electric Company, conducted by him with the assistance of E. E. Schmid, a young engineer of keen talents. They have engaged in the solution of incidental problem pertaining to diverse electrical appliances whose description is impracticable in a non-technical volume. They have constructed trolley lines, designed numerous types of electric railway and transmission materials, and Mr. Foster has accomplished extensive work for the Government in the placing of underground and submarine cables, at West Point and elsewhere in the vicinity of New York.

The activities of the War Industries Board, so much in the public press in the eventful years of 1917 and 1918 were divided into sixteen sections, each under the supervision of a chief. Mr. Foster presided over the "Miscellaneous Section," which by its very title suggests a complexity of detail. The duties of his Board consisted principally in acting as intermediaries between the Allies and American manufacturers, and in apportioning those supplies which happened to be limited in quantity among the Allies and the U. S. Army and Navy. It was a crowded year that Mr. Foster spent in Washington.

The M. I. T., Automobile, Railroad and Engineers' Clubs, and the Kane Masonic Lodge, New York City, are representative of the social affiliations of Mr. Foster. His liking for sports and outdoor life is responsible for his membership in the Greenwich and Blind Brook Country Clubs, and he frequently resorts for relaxation to his country home at Sound Beach, Conn. The officers of the Shield Electric Company are in the Singer Building, New York.

C. C. CHESNEY

CUMMINGS C. CHESNEY

Cummings C. Chesney is one of the pioneers in electrical discovery and has been the associate of other pioneers notable in the history of the science. He made plans for the first polyphase power transmission plant in America to be operated successfully, designed advanced types of alternating current generators for high voltages, and has led in the creation of many other improvements.

Probably Mr. Chesney derived much of his inspiration from William Stanley, famed inventor of the alternating current system of long distance light and power transmission, with whom he had the good fortune to study and collaborate and knowledge of whose life and work he has helped disseminate.

Selinsgrove, Pa., was Mr. Chesney's birthplace, on October 28, 1863. He took the B.S. degree from the Pennsylvania State College, later teaching mathematics and chemistry there and at Doylestown Seminary. He first came in contact with William Stanley in 1888, as a member of the scientist's laboratory forces at Great Barrington, Mass. After spending the years 1889 and '90 with the U. S. Electric Lighting Company, Newark, N. J., he became one of the incorporators of the Stanley Electric Manufacturing Company of Pittsfield, Mass., of which company he was vice-president and chief engineer from 1904 to 1906. On the latter date Mr. Chesney took up the duties of chief engineer and manager of the Pittsfield plant of the General Electric Company, which had absorbed the Stanley Company and where he has since continued. The position Mr. Chesney now holds is one of the most important in the electrical field. The management of the Pittsfield Works of the General Electric Company, devoted principally to the manufacture of transformers, requires intimate knowledge of the vagaries of electricity as well as a trained business and commercial mind.

Mr. Chesney is a Fellow of the American Institute of Electrical Engineers, also a member of the Society of Arts, London, England.

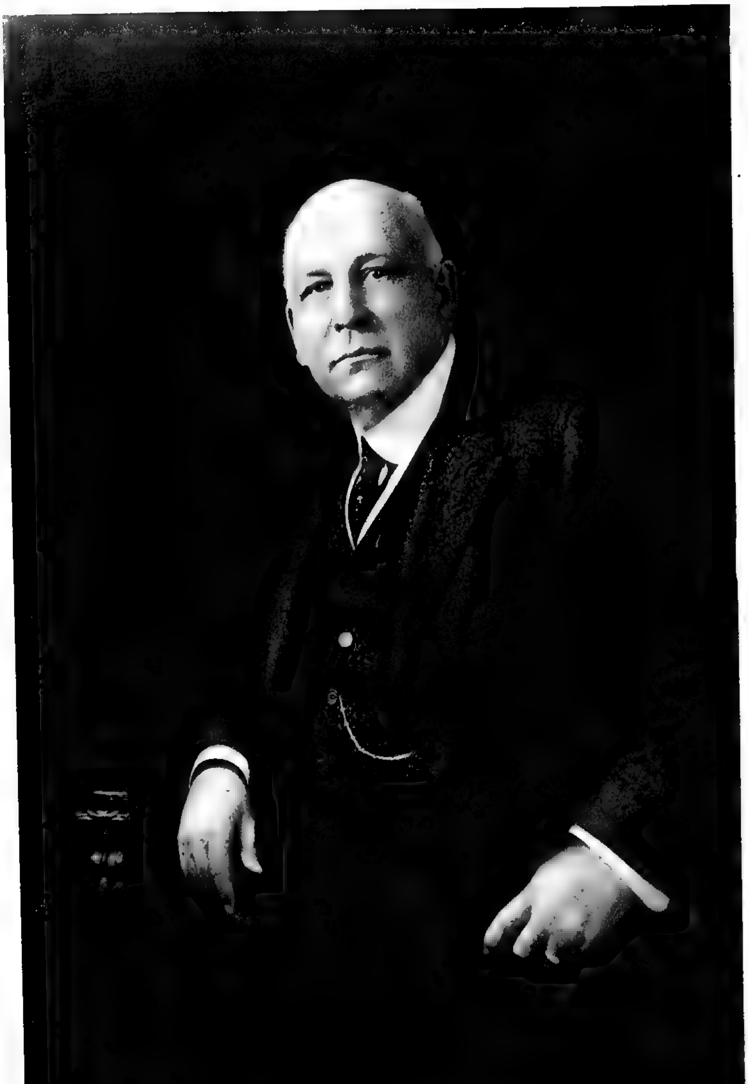
W. G. NAGEL

W. G. Nagel, president and general manager of the W. G. Nagel Electric Company of Toledo, Ohio, has put twenty-one years of concentrated effort into this organization and made a success of it.

At the suggestion of the principal of the public schools at Wapakoneta, Ohio, his birthplace, Mr. Nagel became interested in electrical studies. The higher branches of mechanical and electrical engineering were acquired at the Ohio State University. During his term as undergraduate, Mr. Nagel became a member of the Sigma Nu fraternity. He was graduated in 1895, well prepared for entrance to professional ranks.

Mr. Nagel's first two years of practical experience were spent on the road as a traveling salesman and engineer. It did not take him long to plan the course his career should take for in 1898 he decided to go into business on his own account, settled in Toledo, Ohio, and there organized the W. G Nagel Electric Company, which has since established a secure reputation in the electrical supplies market.

The company operates three departments, one handling supplies and another machinery. The third is employed in strictly manufacturing activities, which are carried on at a plant at 515 Hamilton Street. The output is of varied description, providing for the incidental but important necessities of many industries. Automobile accessories are a feature, and in the catalogue of products are included ammeters, oil indicators, gasoline gauges, oil pressure gauges, and wind shield wipers. The list might be lengthened by other specialties also produced in quantities for the trade. The sales headquarters, including the supplies and machinery departments have exclusive occupation of the building at 28-32 St. Clair Street.



CHARLES LEONARD NEWCOMB

CHARLES LEONARD NEWCOMB

Charles Leonard Newcomb, of Holyoke, Mass., early concentrated his efforts upon applied electricity in the design and manufacture of steam and electrically-operated pumps. He is President and General Manager of The Deane Steam Pump Company, of Holyoke, foremost in the production of electrically-operated pumping machinery. He became associated with this business in April 1881, as Superintendent and Chief Engineer, and has continued in active management, becoming President and General Manager when the Company was merged into the International Steam Pump Co. in 1899, and remaining so after it became a part of the Worthington Pump and Machinery Corporation in 1916.

Mr. Newcomb's policies have been distinguished by a singular foresight in anticipating the onward trend of electrification. For twenty-five years past the adaptation of the electric drive and electric illumination have been a conspicuous feature of his plans and designs, and the improvements in the company's product and manufacturing methods are the results of his faith in the inexhaustible resources of electricity.

The genealogical records of Massachusetts mention Simon Newcomb of Lebanon, Connecticut, who died in 1744. He was a grandson of Captain Andrew Newcomb, who left England for America soon after 1620. Simon Newcomb's son, Hezekiah, in the direct line of descent of the Charles Leonard Newcomb branch of the family, married Jerusha Bradford, a great-granddaughter of William Bradford, famous among the "Mayflower" colonists and an early Governor of Plymouth Colony. Six generations followed Simon Newcomb. Charles Leonard Newcomb is of the last, having been born August 7, 1854, at West Willington, Conn., the son of Charles Leonard Newcomb and Martha Jane (Hudson) Newcomb. Young Newcomb worked on a farm during the summers and in mills and factories in the winters, serving ten years' apprenticeship to the machinist, millwright, and moulder's trades in the Pratt & Whitney shops in Hartford, in textile mills, and in the Murless Foundry, Rockville, Conn. He attended the Worcester Polytechnic Institute, from which he was graduated in 1880 with the B. S. and M. E. degrees. Mr. Newcomb then entered the employ of the American Electrical Lighting Co., New Britain, Conn., later merged with the Thomson-Houston Co., of Lynn, Mass., and into the General Electric Co. Among his associates in those early days were Edwin W. Rice, Jr., now President of the General Electric Co., and Prof. Elihu Thomson, who was developing the Thomson-Houston arc lamp and generators. Prof. Thomson entrusted young Newcomb with the resnonsibility of manufacturing the equipment developed. Some of the first electric searchlights and generators. Prof. Tomson entrusted young ernment use were produced under Mr. Newcomb's supervision.

Mr. Newcomb's broad engineering activities as hydraulic, mechanical and electrical expert, consulting engineer and inventor frequently brought him into contact with public affairs. Notable among them were the condemnation actions and civil suits of the City of Holyoke vs. Holyoke Water Power Co., involving the acquisition by the city of the latter's steam and hydro-electric plants.

Mr. Newcomb has given much in personal service to the community, acting as Councilman and Alderman of Holyoke from 1886 to 1888. He is president of the Holyoke Co-operative Bank. As a member of the original Fire Commission formed in 1892, and its chairman from 1893 to 1911, Mr. Newcomb was a pioneer in applying electric power to propel fire apparatus.

Mr. Newcomb's interest in the field of machinery and engineering is seen in his connection as a founder and official of the National Metal Trades Association and of the National Founders Association, as an ex-president of the New England Foundrymen's Association, manager and member of the council of the American Society of Mechanical Engineers, member of the Engineers' Club of New York, member of the Society of Naval Architects and Marine Engineers, and president of the Engineering Society of Western Massachusetts.

Mr. Newcomb is a member of the Boston Athletic Association, a Knight Templar, a member of the Shrine, and of the Elks. He is, however, pre-eminently a home man, and spends most of his leisure time with his wife and children. He was married in 1874 to Miss Inez Louise Kendall.

PRESTON S. MILLAR

Preston Strong Millar was born on March 9, 1880. He has been identified with the Electrical Testing Laboratories and its work for over twenty years, becoming in January, 1914, general manager and secretary.

Mr. Millar has been engaged in the promotion of the study of illuminants and illuminating engineering. He is a past president (1913) of the Illuminating Engineering Society and is a strong supporter of the work of many engineering and technical organizations. He has presented a number of important papers and reports before the American Institute of Electrical Engineers, the Illuminating Engineering Society, the Association of Edison Illuminating Companies, the American Association for the Conservation of Vision and other bodies, besides being a frequent contributor to the technical press.

In association with Dr. C. H. Sharp, he has designed a new form of portable photometer and has developed the integrating sphere photometer which is now coming into extensive use in the measurement of incandescent lamps.

During the war Mr. Millar served as chairman of the Illuminating Engineering Society's Committee on War Service and as treasurer of the War Committee of Technical Societies.

Among the more recent papers by Mr. Millar are the following: "Study of the Lighting Art," "The Problem of Lamp Testing," "An Unrecognized Aspect of Street Illumination," "Lighting Curtailment," etc.

Organizations to which he belongs are: The American Institute of Electrical Engineers, National Electric Light Association, New York Electrical Society, Engineers' Club of New York, American Association for the Advancement of Science, Association of Railway Electrical Engineers, Old Colony Club, and the Jovian Order.

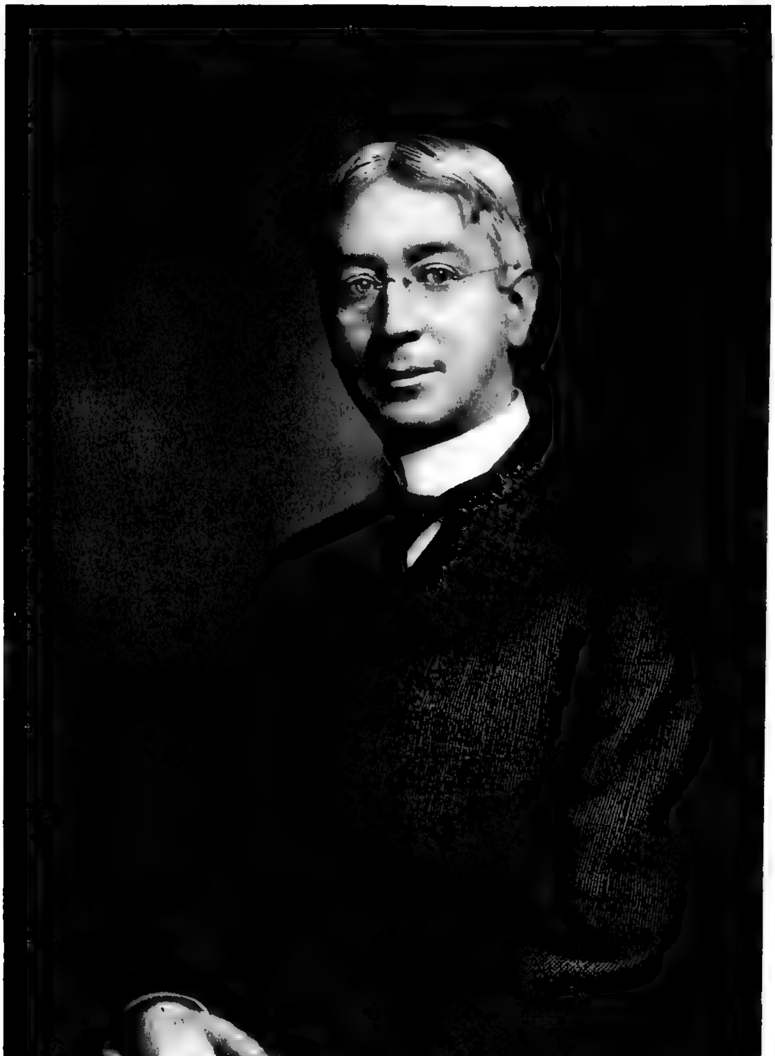
GEORGE A. MURCH

One of the pioneers in the construction and operation of electric railways, George A. Murch, was born in Unity, Maine, August 27, 1861, and was educated in common schools and high schools of Hampden and Bangor, Maine, and in the Castine (Maine) Normal School.

He began his connection with street railways as conductor of a horse car at Salem, Mass., and served on track and in stable, and as driver and in ordinary work in horse railway service. He became foreman of the Woburn Division of the East Middlesex Horse Railroad, and later for one year was superintendent of construction and operation of the Waterville and Fairfield (Maine) Street Railway.

Convinced that electricity would become the motive power of street railways he became connected with the Thomson-Houston Electric Company, for which he was superintendent of construction of the Toledo (Ohio) Electrical Railway, the first electric line in Toledo, and on its completion became treasurer and general manager, for the local Thomson-Houston Company. Returning East he worked and studied in the company's West Lynn factory. He was superintendent of the Attleboro, North Adams and Wrentham Electric Railway one year, then superintendent of construction of the Worcester, Leicester and Spencer Electric Railway for two years. After that, with Charles O. and Charles A. Richardson, Michael McGrath, and W. A. Kendal, he formed the Worcester Construction Company, for all sorts of electrical construction, and for some years had charge of building the Bath (Maine), Calais (Maine), Skowhegan (Maine), Bangor and Orono (Maine), Worcester and Grafton (Mass.), Montpelier and Barre (Vermont) parts of the Blackstone Valley, Mass.; Warren, Brookfield and Spencer, Mass.; Southbridge and Sturbridge, Mass.; Dayton, Ohio; Dayton and Xenia, and other trolley systems. He is now general manager of the St. Albans and Swanton Traction Company, St. Albans, Vermont, and the Public Electric Light Company of that city.

He is a member of the Professional and Business Men's Association of St. Albans and the Owl and Country clubs there.



JAMES BURKE

JAMES BURKE

The salient details in the life of James Burke, as relating to his electrical endeavors, concern the results of his well recognized inventive talents and his authoritive treatment of electrical engineering subjects. The narration of his ceaselessly active career will be to many but the repetition of familiar facts. The Burke Electric Company is one medium through which Mr. Burke has expressed his purposes, and incident to its leadership he brings the tangible issue of much analytical and constructive practice applied in several environments.

The utilization of his inventions is the basis of his own industry, among a goodly number of others made possible by the same creative hand. As a designer of alternating and direct current machinery he has been prolific. Evidence thereof is shown in United States and foreign patent offices where over one hundred patents have been issued to him and their practicality has been commercially demonstrated in a large percentage of cases. For example; the three wire system of generator, affording a three wire service from a single generator has been produced in great quantities by the Burke Electric Company and their licensees. One of his most important inventions is the "Universal Motor" which operates on both alternating and direct current and which is being manufactured by the Burke Electric Company and its licensees in enormous quantities, particularly for portable tools, vacuum cleaners, household labor saving devices, etc.

James Burke, like most men of deeds, had an obscure beginning, hewing out his own pathway by dint of perseverance, talent, and the supreme requisite of having something to give the world. Born April 7, 1873, in England, his education was begun in the English elementary schools and later continued by self-disciplinary methods, intermittently with the aid of private tutors and nearly always at night study after working hours. Electrical studies and experiments held a fascination for him as a boy. He was one who made electrical experiments his pastime and books on elementary physics and electricity his close companions. Approaching his sixteenth birthday, he was in America and had a sufficient store of knowledge to gain admittance to the Edison Machine Works, Schenectady, N. Y., now known as the General Electric Company.

Beginning a service of nearly six years, ending December, 1894, the young engineer passed from one department to another of the Schenectady works, testing and experimenting until he had acquired so thorough an understanding of the processes of manufacture that he was appointed to the staff of designing electrical engineers on which he spent the last three years of his association with that company.

Mr. Burke resigned from his position at Schenectady to embark upon an independent venture. He was ready then to rely upon his own ability as a consulting and designing engineer and so formed the partnership of Herrick & Burke in New York City. While thus engaged in private practice he designed motors and generators for the Bergman Electrical Company of Berlin, Germany. His interest in this commission led him, after three years, to dissolve the firm of Herrick & Burke that he might be free to go to Berlin, there to direct the manufacturing and engineering operations of the aforesaid company. He remained for a term of six years from 1898 as technical director and chief engineer of the Bergman Electrical Company. During his incumbency the prestige of that company was heightened to the degree of making it one of the leading electrical manufacturing companies of Europe.

Mr. Burke's return to the United States was induced by motives eventuating in the Burke Electric Company, the culmination to date of his accomplishments. This company was established July, 1904, since when Mr. Burke has been its president. Meanwhile the business has flourished, obtaining international recognition for its products and maintaining a steady growth. The war-time activities of the company were solely devoted to the nation. No

fuller measure of patriotic co-operation could be offered by any business than to turn over its entire facilities to the Government's needs. This the Burke Electric Company did, manufacturing for war purposes a variety of special electrical machinery and apparatus, the precise nature of which it has not thus far been at liberty to divulge. The factories of the company are at Erie, Pa., which city is also Mr. Burke's business and home address. The company has sales offices in various cities.

Mr. Burke is a Fellow of the American Institute of Electrical Engineers; a member of the American Society of Mechanical Engineers, the American Association for the Advancement of Science, and the Engineers' Club of New York, besides local Erie societies, including the University, Erie and Kahkwa clubs; as well as a member of the Standards Committee of the American Institute of Electrical Engineers and also of the United States Committee of the International Electrotechnical Commission. In May, 1919, Mr. Burke was elected president of the Electric Power Club, which organization includes in its membership the leading manufacturers of electrical machinery in the United States.

I. P. FRINK, INC.

The pioneer reflector concern in this country, I. P. Frink, Inc., was established by I. P. Frink in 1857, at 551 Pearl Street, New York, from whence the Frink daylight reflectors were introduced and came into general use throughout the country I. P. Frink retired in 1881, and Mr. George Frink Spencer assumed active control of the business and still directs its policies. During the early years an extensive field was developed in oil and gas reflecting chandeliers. Frink reflectors became a well-known feature of practically every important building, as indicated by the wide use of these reflectors in the more than 25,000 churches which were equipped with them.

With the introduction of electricity Frink reflectors were quickly adapted to the changed conditions. About this time the firm of I. P. Frink became convinced that the prevalent method of lighting store windows was wrong in principle. The Frink window reflector was developed, whereby the source of light was entirely concealed from the view of prospective customers and the light focused on the goods.

A great variety of new inventions in the lighting field have been successfuly operated with the use of Frink reflectors, and special types of lighting have been developed to meet the peculiar requirements of practically every type of building. Close attention has been paid to the lighting of fine paintings and the illumination of art galleries. Concealed lighting from coves has been brought to a high state of perfection with the cooperation of the leading architects and engineers of the country.

Some few years ago Mr. W. H. Spencer, of the firm of I. P. Frink, invented a decided improvement in the lighting equipment of banks. Frink reflectors are now used as an integral part of the cornice equipments by which the concealed light is evenly diffused over the counters through ground glass diffusing doors. A complete line of double and single desk reflectors of bronze and steel have been devised to suit the varying conditions of any bank.

To fully meet the specific needs of cove lighting, show case lighting, and other lighting novelties, such for example as the Frink Polarite signs, I. P. Frink are now marketing the well-known Frink Linolite lamp. This lamp provides a practically continuous light source, approaching a point source of light, which is of material aid in the careful design of reflecting surfaces so essential to the proper action of the lamp.

The firm took possession of new and spacious quarters in 1910, occupying the five story building at 24th Street and Tenth Avenue. A greater expansion of business than ever experienced in any previous period taxed their resources in the years to follow. In 1916 I. P. Frink were incorporated. The present demand for Frink reflectors represents in large part the call for improved systems of lighting, and under Mr. Spencer's leadership, I. P. Frink, Inc., is one of the foremost houses in its special field.

THE KERITE INSULATED WIRE & CABLE COMPANY, INC.

The names of William R. Brixey and his son Richard D. Brixey are so closely connected as to be almost synonymous with the name of the company with which their life work is identified. It may be of interest to give a brief synopsis here of The Kerite Insulated Wire & Cable Company and its products. The company, as manufacturers of insulated wires and cables, enjoys the highest reputation for its product and business standing. The business is the oldest and among the best known in its line in this country. Kerite Insulated wires and cables have earned an unequaled record of performance in service under all conditions.

The business was founded and established by Austin Goodyear Day, one of the pioneers of the rubber industry in this country, nearly three-quarters of a century ago at Seymour, Conn. Mr. Day finding in his experience with rubber that while it was a very remarkable material, its life was limited, and being by nature of an inventive turn of mind, he determined to try by experimenting with different kinds of material in various ways to develop a substance or compound which could be amalgamated with the rubber and which would preserve its life. After a great deal of research and experiment Mr. Day had the good fortune to succeed beyond even his fondest expectations. He developed or evolved a combination of material under a special process, which not only acted as a preservative of rubber, but was also a remarkably good dielectric. This discovery resulted in his engaging in the wire and cable manufacturing business, using as an insulator his material which he now called "Kerite."

During the Civil War the plant was burned, but was re-built on the original site. Pictures of the factory existing at that time as compared with the present extensive plant of the company show in a measure the expansion which has taken place. As the electrical industry developed, so the business of the company expanded, particularly in later periods under the management of William R. Brixey and then under that of his son, Richard de Wolfe Brixey, both of whom brought to the business at the most opportune time remarkable energy and intelligence in grasping the possibilities and getting the results from the application of Kerite to the larger and more varied uses for which it has since been adopted.

One of the earliest uses for insulated wire was in telegraph work. In this field, Kerite immediately proved its merit and adaptability. In 1868 Prof. Samuel F. B. Morse wrote a letter to Mr. Day commending in the highest terms the use of Kerite for telegraph work. This interesting letter is in the possession of the Kerite Company today.

As the use of electricity developed, so the use of insulated wire and cable developed, and while the developments and new inventions have followed each other rapidly, it has been found that the characteristics of Kerite are such as to more than fully meet all of the requirements imposed by service conditions in all kinds of environment. For this reason and from the fact that the durability of Kerite and its ability to withstand the most severe conditions met in all kinds of service, has been so fully demonstrated, the company has pursued the policy of making nothing but Kerite insulation, feeling that in offering a product which has been proved in service and which has behind it the record of over half a century it is not only offering the electrical industry something of known reliability, but is also, at the same time protecting its own interests in so doing rather than attempting to sell a new product which has no actual proof of service to verify its use.

Kerite is today regarded as the last word in insulation and is used in all kinds of service where reliability and permanency are required. The Kerite Company has the unique distinction of having consistently followed the practice of manufacturing nothing but Kerite and selling it as such, and has refused to alter its product in order to meet the varying specifications which are drawn from time to time, feeling that it can in the long run safely depend on the inherent merits of this product. The Kerite

Company has records of cable still in service which date as far back as 1875. It has wire and cable in service from the Atlantic to the Andes Mountains under every conceivable condition. While the cost of the Kerite product is considerably higher than others, it is in no sense a competitively priced article. The constantly increasing demand for Kerite insulated wires and cables is the best measure of the value of the product and of the policy of The Kerite Insulated Wire & Cable Co.

WILLIAM RICHARD BRIXEY

The arteries of electrical installations are the wires over which flow the current. In this connection, the subject of insulation becomes of great importance and the progress in electrical industries has been due in no small measure to the high degree of perfection attained in the related industry of the manufacture of insulated wires and cables. No more important steps have been taken in that direction than those which resulted from the invention by the late Mr. A. G. Day of the substance known as "Kerite." Mr. Day who was one of the pioneers in the American rubber industry had been much impressed by the need for an insulating material combining efficiency with reliability and permanency, and after painstaking experiments his efforts were rewarded by the qualities he combined in a material to which he gave the name of "Kerite." It soon became widely used as a standard insulation, and was in fact used to such an extent that the term "Kerite" was admitted to the dictionaries as a technical name for an insulated wire. Mr. Day established his original plant at Seymour, Conn., in 1850. In the development of the Kerite industry to a position of commanding influence in its branch of usefulness, a most important event was the entry into the business of Mr. William Richard Brixey. His sister had married Mr. Day, and Mr. Brixey after having joined Mr. Day in the business devoted his attention to the promotion of its prestige and trade, and in course of time, owing to his force and sagacity, became the ruling genius of its later growth and the leading figure in the manufacture of insulated wires and cables in the country. Electrical men will be interested in reading something of the personal career of this man who so impressed himself upon the industry.

Mr. William Richard Brixey was born in Southampton, England, May 11, 1851. He was educated in one of the best known grammar schools in that country, and, conceiving a liking for sea life, he entered the British Mercantile Marine Service, becoming commander of his own ship, trading with all parts of the world, around which he sailed several times, gaining valuable experience and an outlook broadened by extensive travel. He came to this country in 1876, and determining to make the United States his permanent home, became a citizen of this country. Upon becoming associated with Mr. Day, he made an extensive study of the subject of insulated wire and cable for electrical transmission and was soon the manager of the plant at Seymour. Upon the death of Mr. Day, he became the general manager of the entire business, and when his sister, Mrs. Day, died, he became its sole proprietor. Mr. Brixey kept in close touch with the wonderful progress of electrical science and as its applications became more varied, the number of uses for insulated wire and cable increased, and Mr. Brixey continued to add to the users of Kerite, through customers engaged in the various branches of electrical service.

Mr. Brixey suffered a serious injury as a result of the subway explosion at Murray Hill, New York City, in 1902. The injury arose from glass blown into his room in the adjacent hotel, and he was disabled for a considerable time, only his wonderful constitution saving him from a fatal result.

Mr. Brixey was a member of the American Institute of Electrical Engineers. He was for many years a captain of the Old Guard of the City of New York and was a high degree Mason.

Mr. Brixey married, in 1879, Miss Frances N. de Wolfe who was the daughter of Alva G. de Wolfe, who was associated with Mr. Day, and aided him in the perfection of manufacturing processes. Mrs. Brixey died in 1909. Mr. Brixey

WILLIAM R. BRIXEY
(DECEASED)

RICHARD D. BRIXEY

died June 15, 1911, being survived by his three sons, Richard de Wolfe Brixey, Reginald Waldo Brixey and Austin Day Brixey.

In 1908 Mr. Brixey incorporated the business under its present title of The Kerite Insulated Wire & Cable Company, and soon afterward retired, leaving the business to the management of his eldest son, Richard de Wolfe Brixey, who has since been president of the company.

Mr. Brixey had a very wide acquaintance in the electrical field where he was highly esteemed, not only for his achievements in the development and improvement of manufacturing processes, but also for the sterling personal qualities which made him respected of all men. His memory lives as that of a foremost figure in the building up of the great electrical industry and in the training of his son for the further efficient development of the business.

RICHARD DE WOLFE BRIXEY

Richard de Wolfe Brixey, President of The Kerite Insulated Wire & Cable Company, was born in Seymour, Conn., on September 22, 1880. His early life was spent in that town where the large plant of the company is located. As a boy he was deeply interested in the manufacturing end of the business and under his father's guidance spent a large part of his spare time in the plant watching the manufacture of the wires and cables and learning to know the different machines and their processes. From his earliest boyhood he was always ambitious to follow in his father's footsteps and succeed him in the business. He attended the public schools of Seymour from which he graduated with high honors at the head of his class. After graduating from high school, Mr. Brixey entered the Sheffield Scientific School of Yale University where he made a specialty of studies which would be of assistance to him in his life work. He graduated in 1902 with the degree of Ph.B. After his graduation he entered the works at Seymour. While he already had a thorough knowledge of the practical end of the business, having spent a great deal of time in the plant, it was his earnest desire to be absolutely familiar with every detail of the business, and he entered the works as an ordinary laborer, in order to work up from that point. After he had mastered all the details of manufacturing he was transferred to the head office at New York where he proceeded to add to his practical knowledge an understanding of the executive end of the business. In the New York office he went through all the branches in the same way he had at the plant in order to perfect himself as fully as possible for the final management of the business and it was not long before he was made general manager. When his father retired he became the head of the business, and due to the careful training he had undergone, and his natural aptitude, even though a very young man to have such a responsibility placed upon him, he was able to fill the position in a most acceptable manner.

Under Mr. Brixey's direction the business has rapidly expanded. He has brought to its management not only the most complete technical knowledge of the manufacturing and scientific details, but administrative and executive ability of a singularly high order. Through his efforts the company has achieved a position representative of the highest in the industry. Mr. Brixey, however, personally disclaims any credit for the remarkable growth of his company and maintains that it is due entirely to the extraordinary characteristics and merits of Kerite, demonstrated in actual service.

Mr. Brixey married in Jersey City Heights, Jersey City, N. J., in November, 1905, Bertha Marguerite Anness and has one daughter, Doris Marguerite.

Mr. Brixey is a member of the Engineers' Club, Yale Club, Sleepy Hollow Country Club, Essex County Country Club, The Pilgrims' Society, Electrical Manufacturers' Club, Railroad Club, Machinery Club, and the Quinnipiack Club of New Haven. He is a member of the American Institute of Electrical Engineers, American

Chemical Society, the American Society for Testing Materials, the Associated Manufacturers of Electrical Supplies, the Railway Signal Association, the American Electric Railway Association, the Association of Railway Telegraph Superintendents and the Morse Electric Club.

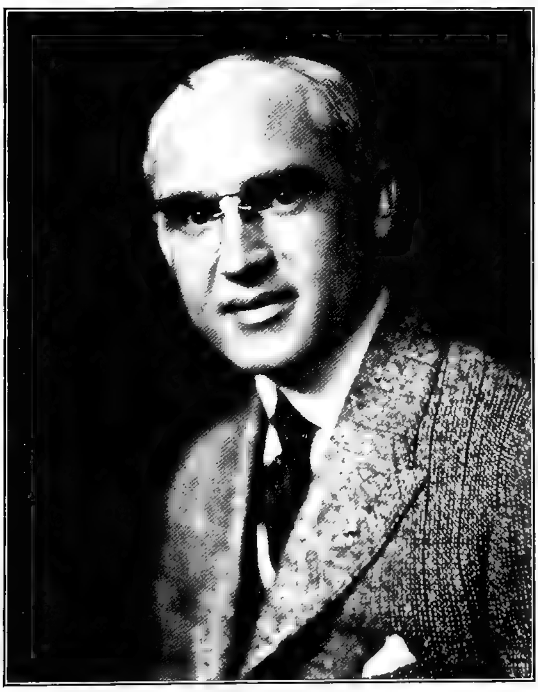
In 1900 Mr. Brixey took advantage of an opportunity to obtain experience in the laying of submarine cables and went as part of an expedition to lay a cable in Alaska. He not only gained experience in the handling and laying of submarine cables, but also had an experience in the form of a shipwreck, which was not a part of the original schedule, when the ship, during the course of laying the cable, ran on to an unchartered reef about which nothing was known until the cable ship located it, resulting in the loss of the ship. The cable was salvaged and was afterwards laid. The unique part of the shipwreck lay in the fact that when the ship ran aground assistance was called for through the cable which had already been laid and boats were sent out and arrived in time to save every one on board.

In 1904 Mr. Brixey went to Europe to investigate the manufacture of wires and cables developed there.

Mr. Brixey is recognized as a man of keen judgment and is an example of the highest type of American business man in all that the term implies.

ARTHUR B. STITZER

The Union Traction Company of Philadelphia engaged Arthur B. Stitzer as draftsman July 5, 1899. Four years later he was electrical engineer in charge of the design, construction and erection of the machinery and equipment used by the company for the generation and utilization of electricity, being eleven years in the company's service.



ARTHUR B. STITZER

Mr. Stitzer was born July 20, 1877, at Hackettstown, New Jersey. He won the city scholarship in the University of Pennsylvania, graduating in 1899 with the degree of bachelor of science, and taking the degree of electrical engineer in June, 1909, from that institution.

Mr. Stitzer participated in important projects as electrical engineer with the firm of Ford, Bacon and Davis. Since then he has become chief engineer for the Republic Railway & Light Company and also for the Republic Engineers, Inc., two enterprises administered from 60 Broadway, which is the center of the Harrison Williams interests.

Being a fellow of the American Institute of Electrical Engineers, a member of the Society of Mechanical Engineers, the Franklin Institute, the Engineers' Club of Philadelphia and the American Electric Railway Association, Mr. Stitzer is familiarly known in technical cirles.

BANCROFT GHEPARDI

BANCROFT GHERARDI

The appointment of Bancroft Gherardi to the post of chief engineer of the American Telephone & Telegraph Company, July 1, 1919, only emphasizes the recognition accorded him by all members of the telephonic fraternity.

It was in the office of John J. Carty, who was then, in February, 1895, engineer of the Metroplitan Telephone & Telegraph Company, the predecessor of the New York Telephone Company, that the youthful Gherardi took up the first of the unbroken sequence of telephone engineering tasks that have since marked his advancement in the profession. Prior records state that he was born at San Francisco, Cal., April 6, 1873; was graduated from the Polytechnic Institute of Brooklyn, N. Y., with the degree of B.S., in 1891; and went to Cornell University, where he specialized in mechanical and electrical engineering, was a Chi Psi Fraternity man, took Sigma Xi honors, and received the M.E. degree in 1893 and the M.M.E. degree in 1894.

Inspecting and testing cables was Gherardi's initiatory duty under the tutelage of Mr. Carty, who in due course placed him in charge of the material inspection work of the company, which was followed by a greater commission, no less than the supervising of a fundamental plan for 100,000 lines within Manhattan and the Bronx. The traffic department of the New York Telephone Company, in 1900, next claimed the services of Mr. Gherardi, and under his direction and that of Mr. Carty was created the first traffic engineering department in existence. In 1901 Mr. Gherardi became chief engineer of the New York & New Jersey Telephone Company, which, though operating independently, was of necessity closely allied with the New York organization. He prepared fundamental plans for Brooklyn and other cities in the company's territory. Ensuing events in his administration were the conversion of the plant to a common battery basis, and, loading having been invented, the placing of a loaded cable between New York and Newark, which was the first commercial application of cable-loading to a telephone plant. The two companies mentioned were consolidated in March, 1906, the chief engineer of the New Jersey Company becoming assistant chief engineer of the combined forces, and again acting under his former mentor, Mr. Carty.

When Theodore N. Vail became president of the American Telephone & Telegraph Company in 1907, Mr. Carty was made chief engineer and concordantly Mr. Gherardi was appointed equipment engineer, later, in 1909, taking the post of plant engineer in charge of plant development and standardizing for the Bell System. For the year preceding July 1, 1919, he was acting chief engineer of the company.

The mere recital of Mr. Gherardi's official capacities gives no more than an inkling of the consequential movements in which he was concerned. Among these were the subway and cable construction from Boston to Washington, lines from New York to Denver, the transcontinental line, and, in 1916, the wireless telephone demonstrations of the American Telephone & Telegraph Company, including transatlantic wireless from Washington to Paris, and wireless from Washington to Hawaii. Mr. Gherardi performed important confidential work for the Government during the war.

The present Bancroft Gherardi is the second of that name distinguished in the history of telegraphy. His father, Rear Admiral Bancroft Gherardi, U. S. N., took a leading part in the laying of the first transatlantic cable. The son is a great-nephew of the late George Bancroft, the noted historian and former Secretary of the Navy.

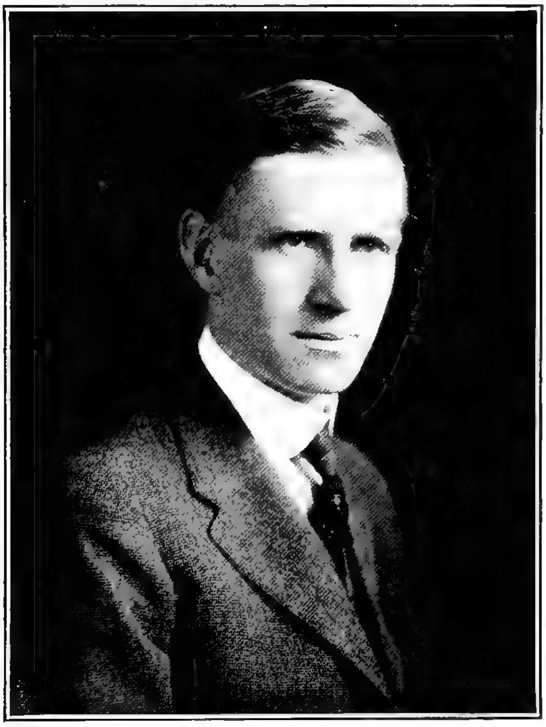
Mr. Gherardi is an honored member of the American Institute of Electrical Engineers, having served as a member of the Board of Directors of the Institute and as vice-president. He has been president of the Telephone Society of New York. Other affiliations are with the American Society of Mechanical Engineers, the Franklin Institute, and the New York

Electrical Society. He is a member of the University, Engineers', and Machinery Clubs, of New York; the Baltusrol Golf Club, Short Hills Club, and Bay Head Yacht Club.

Mr. Gherardi married Miss Mary Hornblower Butler in June, 1898. During the winter they reside at Short Hills, N. J., and have a summer home at Bay Head, N. J.

ALLAN COGGESHALL

The distinguishing mark of Allan Coggeshall's work in electrical engineering has been his effectual meeting of conditions imposed by the advancing standards of electrical contracting, particularly respecting the application of electricity to industrial plants. The origination of various forms of flexible distributing systems in manufacturing plants, the maintenance of operating systems in them, together with educational developments within the profession, have been subjects of engrossing study during his incumbency of influential positions in this field. The brief notations following herewith are in themselves an indication of such variety of interest and of an unusual degree of versatility.



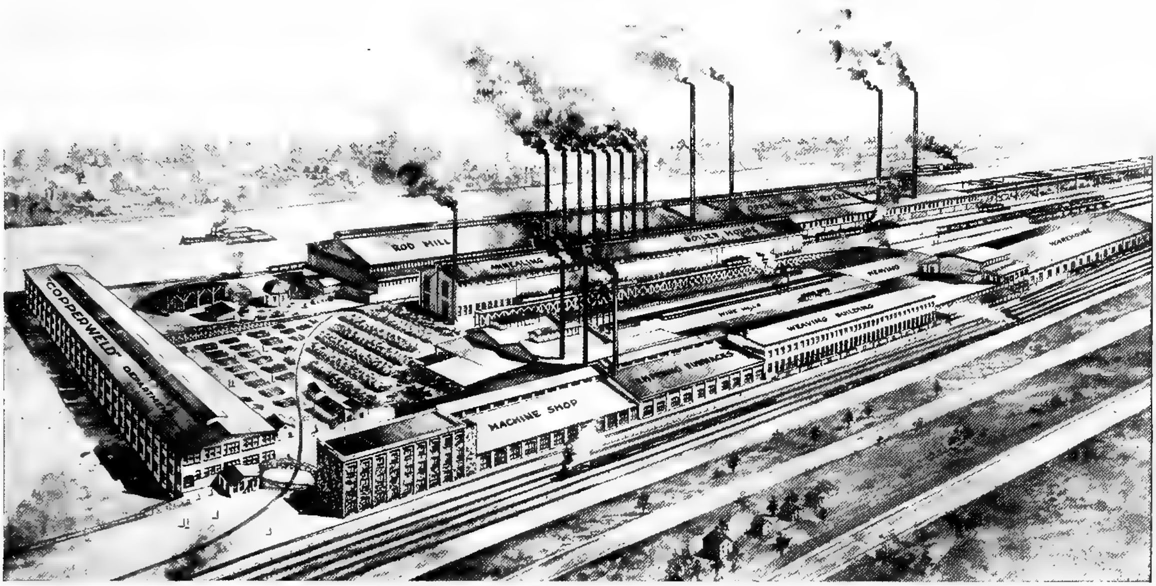
ALLAN COGGESHALL

Mr. Coggeshall had ancestral precedents for his choice of a vocation. On his mother's side the families of Bancroft and Sellers followed mechanical and electrical pursuits for generations back. October 12, 1881, at Orange, New Jersey, Allan Coggeshall was born. Preparatory studies at Carteret Academy and electrical engineering courses at Columbia University made up the sum of his academic education. He was graduated from the latter in 1903 with an E.E. degree.

The New York Navy Yard formerly had what was called the equipment department, which inspected and tested all electrical material and apparatus to be used on shipboard. Fresh from the class room, Mr. Coggeshall obtained two years' experience, 1903-1904, as a sub-inspector. The Ohio State University then engaged him for assistant professor of electrical engineering—an evidence of his recognized capability in the science—and there he spent the next three years. He returned to New York in 1907 to join the staff of the New York Telephone Company, being for two years thereafter connected with the plant department of the Long Island division. The electrical contracting firm of L. K. Comstock & Company drew him into their service for the period of 1909 to 1916.

In 1917 Mr. Coggeshall became identified with Hatzel & Buehler, Inc., electrical contractors, of which he is now vice-president and a director. His offices are with the firm at 373 Fourth Avenue, New York City. Mr. Coggeshall is an associate of the American Institute of Electrical Engineers and a member of the Phi Gamma Delta Club of New York, and the University Club of Bridgeport.

PAGE STEEL AND WIRE COMPANY



Plant of the Page Steel and Wire Company, Monessen, Pa.

Among the pioneer industrial firms of the United States, the Page Steel and Wire Company has earned a notable and enviable position. Founded at Adrian, Michigan, in 1883, it originated the manufacture of woven wire fencing and by persistent research, experiment, and development of new processes, established itself firmly among America's leading manufacturers of the highest grade wire products.

The continuous growth of the business in its earlier years made necessary the erection of new and large steel and wire mills. In 1899, open hearth furnaces, together with mills and laboratories of the most modern design and equipment, were built at Monessen, Pa.

The policy of the firm has been "quality first," and the chemical and physical laboratories were made scientifically perfect so as to insure steady improvement and the output of the best wire possible at the time of manufacture.

The company is now manufacturing high carbon rope wire, spring wire, and other high grade wire made from steel of certain and special analyses. A new and specially equipped plant is devoted exclusively to drawing Aristos "Copperweld" copper clad steel wire under a distinctive process which firmly unites the copped coating with the steel core.

Another product which has brought the firm commercial success is Armco (American Ingot) iron wire. This is one of America's war-time industrial triumphs. Previous to the commencement of hostilities in 1914 the United States imported from Europe most of the materials for welding the mild steel and wrought iron required in wire making, but when supplies were no longer forthcoming the Page Steel and Wire Company undertook the production of suitable American-made welding rods. The result has been remarkable, and all tests and applications prove that the labors of the firm's metallurgists and laboratory specialists have developed a welding material which in toughness, density, homogeneity, and in freedom from segregated impurities and occluded gases, is superior to anything ever imported. Armco iron welding rods have been standardized in a single composition in two tempers, one for *oxy-acetylene* and the other for *electric* welding, and this standard composition does all the work — with better results—that heretofore has required a choice of one from many compositions.

In addition to the plant at Monessen, Pa., the Page Steel and Wire Company has one at Adrian, Mich. The domestic and export sales offices are at 30 Church Street, New York City.

J. HENRY HALLBERG

There are those who inherit, those who achieve, and those to whom is added success in the electrical profession, to paraphrase the familiar saying. J. Henry Hallberg may have inherited the inclination, but he achieved for himself a very uncommon mastery of practically applied electricity. He is a business man who has looked into the electrical needs of ordinary, popular and commercial pursuits and has supplied economical, practical devices to meet them.

Mr. Hallberg's relation to the motion picture theater and its promoters, while his energies have not at all been devoted exclusively to this industry, is illustrative of results he has secured. By means of a series of well-timed inventions applicable to the equipment of motion picture houses and the projection of pictures, his name has gained high repute in the motion picture industry.

The birthplace of Mr. Hallberg was Falkenberg, Sweden, where he was christened Josef Henrik Hallberg in the year of 1874. The Latin-Laroverket at Halmsted, Sweden,—the equivalent of the American advanced high school or college—graduated him in 1890, with which preparation he embarked for America, where he has since made his home. One phase of his later career is seen in the list of his thirty-one patents. There are five patents taken out on enclosed arc lamp designs; seven on constant current A. C. regulators for street lighting; one on an eddy current electric water and air heater; five on a system of electric distribution for railway and light plants; three on a single to polyphase railway system; one on a carbon brush contact device; six on flaming arc lamps; one on an instantaneous electric water heater; one on an automatic cut-out for series incandescent street lamps; and one on a system of electric distribution for projector arc lighting. Some of the earlier inventions have outlived their day, while others have not been favored by the circumstances and conditions necessary to commercial production. The single to polyphase railway system, for instance, failed of materialization for no inherent lack, but because its adoption would have meant a physical reorganization of all roads upon which it might have been used. Approved by electrical authorities and railway experts, and possessing superior advantages of economy and simplicity of operation, it still awaits employment. But other of the enumerated inventions are the basis of a thriving industry. Of them more is to be said.

The biographical data on the life of Mr. Hallberg discloses a climb upward from the uninspiring level of a trade apprentice. Beginning on the date of his arrival in America, he worked with a single-minded purpose. The first three years were spent in the Ottumwa Iron Works, at Ottumwa, Iowa, gleaning experience on the construction and operation of steam engines and coal mining and hoisting machinery. A brief connection with Kohler Brothers, contracting engineers, of Chicago, was followed by the position of sales engineer with the Electric Appliance Company of Chicago, after which ensued a three-year term ending in 1899 as electrical engineer and designer for the Standard Thermometer & Electric Company of Peabody, Mass.

Between 1899 and 1903 Mr. Hallberg began to attain increased prominence. He was then a designer and engineer with the General Incandescent Arc Light Company, New York, developing a complete assortment of enclosed arc lamps, alternating-current regulators, automatic transformers, switchboards, and protecting devices. Thereafter street lighting systems became a specialization in which he accomplished works of note. The greatest arc lighting installation of its time, in Cincinnati, Ohio, was made under his supervision. Mr. Hallberg was appointed general superintendent and electrical engineer of the Cincinnati Gas & Electric Company in 1903.

After 1904 Mr. Hallberg had his own office in New York City, where he engaged in the practice of a consulting engineer. His clients numbered firms of such rank as the Atlantic Mills, of Providence, R. I.; A. D. Juilliard & Co., New York; the Standard Silk Company, Phillipsburg, N. J.; the Stanley G. I. Electric Manu-

J. HENRY HALLBERG

facturing Company, Pittsfield, Mass.; and the Jacob Ruppert Brewing Co., New York. He was at one time a consulting and advisory engineer to the Commission on Municipal Electric Lighting of New York City, and he served the National Carbon Company, Cleveland, O., as consulting expert in matters pertaining to carbon for electrical purposes.

Mr. Hallberg's advent into the motion picture business came about as a result of his interest in the improvement of motion picture projection and the electrical equipment of theatres. His electrical "Economizer," flaming arc lamps, special terminals, and connectors, for use in the picture houses, drew him gradually into closer association with the manufacturers and consumers of this kind of equipment.

Principal among the interests with which Mr. Hallberg has been identified since 1914 is the United Theatre Equipment Corporation, of which he is vice-president, engineer, and director. They are the world's largest distributors of electrical equipments and supplies for motion picture theatres and for motion picture production and exhibition purposes in general. Eleven branch stores serve all the centres of population throughout the country.

The Standard Slide Corporation, of which Mr. Hallberg is vice-president and a director, is a consolidation of the formerly leading individual firms in the slide trade, the merger constituting the greatest existing manufacturing unit of its type, with a production of fifteen thousand slides a day, for educational, commercial, and motion picture trade purposes. As vice-president and director of the Kansas City Machine & Supply Company, Inc., Mr. Hallberg assists in the direction of the second largest distributing agency for electrical and motion picture equipments and supplies, and whose activities are conducted in the middle and western states. He occupies similar positions in the Feature Film and Calcium Light Company of Pittsburgh, Pa.

Mr. Hallberg has succeeded in developing and popularizing several ingenious electrical mechanisms that have carried his name over the world. One is the Hallberg motor generator for all cycles, which changes alternating to direct current without rheostat for the arc. It is the pioneer generator for its purpose and combines many heretofore unknown advantages, including the ability to deliver the maximum ampere output of the generator to either one of the arcs. The Hallberg D. C. to D. C. motor generator has also done away with the rheostat and has permitted improved projection with a 30% to 80% reduction of electric current consumption.

Another Hallberg invention called the "4 in one" automatic regulator is a boon to the motion picture operator. It is a regulator for the control of 25 to 30 volt mazda motion picture projector lamps of 600-750 and 900 watts, is unique in being the first and only regulator offered to the trade, and consists of a transformer with absolutely separate line and lamp coils. The Hallberg electric economizer controls a carbon arc on alternating current 110 or 220 volts, takes the place of a rheostat, saves 66% on 110 volts, 82% on 220 volts, and improves the light at least 50%. The Hallberg portable projector for motion pictures is a wonder of compactness and efficiency. It weighs only twenty-two pounds, yet is thoroughly practical for either professional, commercial, or amateur usage. Portable and stationary electric light plants, the Hallberg "Inca Light" system, and sundry minor contrivances, complete Hallberg's prolific contributions to picturedom.

The inventor's writings have been on a par of usefulness with his other work. Besides technical papers and articles, he is the author of a comprehensive working treatise, "Motion Picture Electricity." He was intrusted with the writing of the chapter on "Arc Lamps and Arc Lighting" in "Foster's Electrical Engineer's Pocket-Book"; and he has frequently lectured on electrical subjects at Columbia University.

Mr. Hallberg is vice-president and director of the National Association of the Motion Picture Industry, an associate of the American Institute of Electrical Engineers, and a member of the National Electric Light Association, the National Association of Manufacturers, New York; the Society of Motion Picture Engineers, and the Swedish Engineers' Club of America.

He was a member of the War Cooperation Committee of the Aircraft Division of the War Industries Board, and technical director on the Fuel Conservation Committee of the National Association of the Motion Picture Industry.

In off hours Mr. Hallberg indulges in photography, in which he has more than amateur skill. A yachtsman, too, he belongs to the Columbia and New Rochelle Yacht Clubs.

Mr. Hallberg's New York City offices are with the United Theatre Equipment Corporation at 1604 Broadway. His personal address is 445 Riverside Drive, New York.

GEORGE I. RHODES

George I. Rhodes, manager of the engineering department of Ford, Bacon & Davis, New York, commands a position of respect and consequence in metropolitan engineering circles by reason of both personal and professional qualities. His association with Ford, Bacon & Davis in itself brings him within the sphere of advanced engineering practice, and in the American Institute of Electrical Engineers and elsewhere he is well known to the fraternity.

Mr. Rhodes is a New Englander. He was born at Andover, Massachusetts, November 27, 1883. Very natural was it that, having the inclination toward scientific studies, he should have sought the Massachusetts Institute of Technology, where he was graduated in 1905.

The first working connection that Mr. Rhodes formed was fortunately in a place of opportunity with the Interboro Rapid Transit Company of New York, which engaged him as an electrical engineer in the motive power department, where he was under the superintendent, the late eminent engineer Mr. H. G. Stott. Between this experience and his alliance with Ford, Bacon & Davis, Mr. Rhodes held only one post, that of consulting engineer to the firm of White, Weld & Company at the Boston branch under the direction of Philip Cabot.

Mr. Rhodes makes his home at Glen Ridge, N. J. His offices are at 115 Broadway, New York.

THE NATIONAL DISTRICT HEATING ASSOCIATION

A Brief Review of an Organization of Merit.

The National District Heating Association, which is closely allied with central station work, was founded in 1909, the original organizers being W. A. Wolls of Columbus, E. F. Gwynn of Delaware, D. J. Hard of Cleveland, and A. C. Rogers of Toledo. Mr. Gwynn is now deceased, but each of the other originators are living and holding the business positions which they had at that time. Mr. D. J. Hard held the rank of Colonel in the late war and did efficient service in France and is still at the head of the Cleveland Light and Power Company. Mr. Wolls continues with the Columbus Railway, Light and Power Company, and Mr. Rogers is still connected with the Toledo Railways & Light Company.

The organizers of the association held their preliminary meeting in July, 1909, and called a convention to be held in the city of Columbus in November of that year, at which time the association may be considered to have been officially and permanently organized. Nearly all of the members of the association are connected with the electric light industry, and practically all of the district heating plants in the country are operated in connection with the local electric lighting companies.

As an illustration of the usefulness of this organization, it is noted that at the close of the convention in 1909 the association had 32 members, and ten years later, in 1919, it enrolled nearly 400 members. Membership in the association is

classified as follows: Class "A," Class "B," Class "C," and "Associate" members. Class "A" being the operating companies and those engaged actively in operating district heating plants; Class "B" being employees or officers of Class "A" members; Class "C" being those engaged in plumbing and "Associate" those engaged in the manufacture of appliances to serve such companies. The majority of the membership is rated under Class "A."

Since the organization in 1909, conventions have been held each year with the exception of 1918, which was omitted on account of the war. This association has probably done more than any other organization in gathering information in reference to heating; but its work has not been confined entirely to that subject but has been extended to plant operation, public policy questions and other matters affecting and helping central stations in the complexity of their responsibilities. One of the notable achievements of the association has been the establishment of a standard rule for computing required radiation, which was completed and adopted at the convention in 1919.

The association has published its proceedings in a bound volume each year, and these are classed as standard reference works upon the subjects covered. In 1916 it established its own publication known as the *Bulletin of the National District Heating Association,* which is issued quarterly and which has done much to help in the work.

At the convention of 1909, Mr. D. L. Gaskill, of Greenville, Ohio, was chosen as Secretary and he is still serving in that capacity, and the headquarters of the association have been located in the office of the secretary in Greenville since the first convention.

The past presidents of the association are as follows: A. C. Rogers of Toledo, George W. Wright of Baltimore, A. D. Spencer of Detroit, R. D. DeWolf of Rochester, S. M. Bushnell of Chicago, H. R. Wetherell of Peoria, D. S. Boyden of Boston, B. T. Gifford of Grand Rapids, Geo. W. Martin of New York, and J. C. Hobbs of Pittsburgh, who is the present encumbent.

Conventions have been held in Columbus, Toledo, Pittsburgh, Detroit, Indianapolis, Rochester, Chicago, New York, Detroit, and Pittsburgh, two each having been held in Detroit and Pittsburgh. Mr. W. A. Wolls acted as secretary at the preliminary organization meeting and had charge of the first convention held at Columbus, since which time the present secretary has filled the office.

The work of the standing committees of the association has been very strong and their reports have obtained international circulation. The association is in excellent condition and is regarded as one of the strong features of the electrical organism, and as working industrially and unceasingly for the betterment of conditions as they arise in the industry.

CHAPTER XVII

THE INTERNATIONAL BROTHERHOOD OF ELECTRICAL WORKERS

An Organization Embracing One Hundred and Thirty Thousand Workers in the Electrical Field

THIS Brotherhood was organized and chartered by the American Federation of Labor, November 28, 1891. The first meeting of the organization was held in the city of St. Louis, there being in attendance representatives from associations of electricians from St. Louis, Chicago, Duluth, Milwaukee, Indianapolis, Evansville, Toledo, and Philadelphia. The names of those attending this meeting were J. T. Kelley, Henry Miller and W. Heddin of St. Louis; T. J. Fennell, Chicago; J. G. Sutter, Duluth; M. Dorsey, Milwaukee; E. Harting, Indianapolis; F. Heizelman, Toledo; Joseph Burlitz, Philadelphia, and H. Fisher, Evansville.

The title selected for the organization at that time was National Brotherhood of Electrical Workers of America. Henry Miller was elected president; J. T. Kelley, secretary-treasurer; J. Harting, first vice-president; F. Heizelman, second vice president. Thus an organization of electrical craftsmen was formed, its numerical strength being somewhat less than one thousand with seven affiliated local unions.

There was little to encourage this small group of men. The opposition to unions at that time was active and bitter, but by the untiring efforts on the part of those selected to officer the organizations, when the next convention was held November 14, 1892, at Chicago, there were twenty-four locals represented, and a total of forty-three local unions affiliated with the organization. The records of the convention show that the average wage for journeymen at that time was $1.50 per day, and the hours of work were from ten to twelve, and in many cases even longer. Quite extensive plans for extending the organization and reducing the hours of work and increasing the wage rate were made at this meeting, but closely following the adjournment of the convention the panic of 1893 occurred, and resulted in the organization receiving a serious set-back. Out of the total of forty-three locals twenty-nine became defunct.

Those responsible for the administration of the organization's affairs at this time, while greatly disheartened, continued their efforts and brought it through the crisis successfully, and from that time on, continued growth and progress has been made.

At the Pittsburgh convention, 1899, it was shown that the growth of the Brotherhood had extended into Canada, and having in mind the international feature the name was changed from National to International Brotherhood. The extension of the Brotherhood's activity to Canada was a well advised move and developed a strong fraternal bond between the electrical workers of the United States and those of the Dominion of Canada.

The progress and growth of the International Union has been steady; and from the insignificant beginning of less than one thousand members it, at present, has a paid up, good-standing membership of one hundred and thirty thousand members, all of whom are occupied with the physical work of manufacturing, installing, maintaining, and repairing the apparatus neces-

sary for the generating and utilization of electrical energy. From the frozen confines of the Yukon and Hudson Bay to the tropics of Panama these members will be found devoting their time to harnessing that great force which has brought so many comforts, conveniences and necessities to the human race.

Over eleven thousand members of the organization responded to the call to arms in the World's War. Thirty per cent of the entire membership in the Dominion of Canada enlisted in the Canadian forces. The members who responded to their country's call quite naturally were absorbed by the signal corps of the United States and Canadian armies, a hazardous branch of the service which resulted in heavy casualties. Notwithstanding this the International Union exempted from payment all members who served in the armies or navies of the Allied countries, and also paid full death benefits to those who made the supreme sacrifice.

CHARLES P. FORD
International Secretary

The officers of the Brotherhood are as follows: President, F. J. McNulty, Newark, N. J., elected September, 1905, Louisville, Ky., Convention; Secretary, Chas. P. Ford, Schenectady, N. Y., appointed to fill vacancy July, 1912; Treasurer, Wm. A. Hogan, New York City, elected Chicago Convention, September, 1909. Vice-Presidents: Jas. P. Noonan, St. Louis, Mo., elected Louisville Convention, 1905; G. M. Bugniazet, New York City, elected Rochester Convention, 1911; L. C. Grasser, Oakland, Cal., elected Rochester Convention, 1911; E. Ingles, London, Ont., Can., elected Atlantic City Convention, 1917. Executive Board members: Frank L. Kelley, Boston, Mass., elected Rochester Convention, 1911; George W. Whitford, New York City, elected Rochester Convention, 1911; Edward Nothnagel, Washington, D. C., elected St. Paul Convention, 1915; M. P. Gordan, Pittsburgh, Pa., elected Rochester Convention, 1911; M. J. Boyle, Chicago, Ill., elected Boston Convention, 1913; Frank Swor, Dallas, Texas, appointed to fill vacancy September, 1909; T. C. Vickers, Fresno, Cal., elected at Boston Convention, 1913.

Those entrusted with the administration of an organization's affairs define the general business policy of the organization, and nothing could be more important to the Brotherhood than its business relations. The policy established by the officers and in force at this time has won the confidence and respect of the great majority of electrical employers of the United States and Canada.

The organization, while primarily a labor organization, does not overlook the importance of conducting its affairs as a business institution, neither does it overlook the advantages of trade education for its membership. Each of the over nine hundred local unions has established educational features. A portion of the time of each business meeting is given over to lectures and discussions on practical electrical subjects. Trade schools for apprentices have been started, providing an opportunity for the apprentice to obtain a technical as well as practical understanding of the business. It is said that no other organization of labor has such diversified interests as the electrical workers. There is practically no limit to its field of operations and no branch of industry is independent of the electrical worker.

CHARLES P. FORD,
International Secretary.

ADDENDA

Lieutenant-Colonel Byllesby, of whom an engraving appears opposite page 135, while in Europe during the war served the United States Army as the London representative of the Purchasing Bureau of the American Expeditionary Forces, having charge of purchasing in Great Britain and the Scandinavian countries. He returned to the United States, was honorably discharged December 19, 1918, and resumed active duty as president of H. M. Byllesby & Company. He has received the Distinguished Service Medal from the British Government.

Mr. James F. Hughes, whose photograph and sketch appear at page 261 of this volume, died on January 24, 1919. Mr. Hughes had not been active with his firm for some time, and his lamented death will not curtail the commercial progress of the company.

Charles Edwin Knox, for many years a leading consulting electrical engineer, see page 563, died at the St. Luke's Hospital on June 1st, 1919.

Louis K. Comstock, electrical contracting engineer, whose sketch appears on page 175, has removed his offices from 30 Church Street to 21 West 40th Street, New York.

Ray Palmer, whose sketch appears on page 362, has changed his address from 444 Jackson Avenue to the Bridge Plaza, Long Island City.

Welcome I. Capen, late vice president of the Postal Telegraph Company, see page 293, died at his home in Mt. Vernon, New York, April 18th, 1919.

James T. Maxwell, for many years with the Philadelphia Electric Company, see page 296, died at his home in that city since the above sketch was printed.

In June 1918, Dr. Miller Reese Hutchison, in order to devote his entire attention to the Government as a member of the Naval Consulting Board, disposed of such commercial interests as necessitated his personal attention. About Jan. 1st, 1919, he opened offices of Miller Reese Hutchison, Inc., on the 51st floor of the Woolworth Building, N. Y., where he is now engaged in special engineering development and construction work in the U. S. A. and overseas.

In addition to the clubs and societies mentioned on page 258 in Dr. Hutchison's sketch, he is also a member of the Automobile Club of America, New York Athletic Club, Kappa Alpha (Southern) Fraternity and vice-president and treasurer of the Corporation of Industrial Engineers of New York City.

William S. Murray, whose sketch appears on page 353, chief electrical engineer of the New York, New Haven & Hartford Railroad for many years, who has heretofore maintained headquarters at New Haven, Conn., has moved his engineering offices to 165 Broadway, New York City. He will devote his time to consultation on electrical generation and transmission, railroad electrification, and conservation of natural resources.

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